

The University of Chicago

THE GENESIS OF  
HAND PREFERENCE

A DISSERTATION SUBMITTED TO THE  
FACULTY OF THE DIVISION OF THE  
SOCIAL SCIENCES IN CANDIDACY FOR  
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATION

1935

By  
MINNIE GIESECKE

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Reprint of

MONOGRAPHS OF THE SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT  
Vol. I, No. 5, 1936



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The writer wishes to acknowledge her indebtedness to Dr. Frank N. Freeman for invaluable advice and encouragement throughout the progress of this study. She also wishes to express her thanks to the kindly mothers whose cooperation made the study possible, as well as to the young subjects themselves, who responded so gratefully to blocks and stop watches and who incidentally gave the experimenter much practical understanding of child development.



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## CHAPTER I

### INTRODUCTION

That the nature of hand preference is yet a moot question may be concluded from an examination of the literature in the field. On the one hand may be found investigators who consider right and left-handedness to be inherited traits<sup>1</sup> while on the other hand other investigators may be found who consider these characters to be largely the result of environmental influences.<sup>2</sup>

The theory that hand preference is the result of eye preference is a view prevalent in current writing,<sup>3</sup> but this theory is flatly denied by some investigators<sup>4</sup> while others consider both hand and eye preference to be related aspects of a general sidedness.<sup>5</sup>

The possibility that hand preference is related to functional asymmetry of the brain is argued by certain writers,<sup>6</sup> while doubt is cast upon this view by others.<sup>7</sup>

Finally, even the assumption upon which educational interest in hand preference is largely based, namely its possible relationship to difficulties in speech, reading, and writing, is challenged by some investigators<sup>8</sup> while others<sup>9</sup> hold this to be a most significant development in speech pathology.

#### Evidence Concerning Genesis of Hand Preference

It would seem self-evident that some light might be thrown upon the nature of hand preference by careful investigation of its genesis in early infancy, yet such investigations are remarkably few in number.

Biographical material.- The largest body of material concerning hand preference at early age levels is to be found in the biographies and reports on individual babies so popular during the child study period of the later 19th and early 20th centuries. While these studies are not to be considered sources of exact scientific knowledge concerning the earliest development of handedness, they do point the way for more accurate investigations and also give some indication of the individual differences to be expected in this as in other human traits.

Major studied his child with the object of discovering something about

<sup>1</sup> W. Ludwig, Rechts-Links-Problem im Tierreich und beim Menschen, pp. 305-310. Berlin: Julius Springer, 1932.

<sup>2</sup> Albrecht Bethe, "Zur Statistik der Links- und Rechtshändigkeit und der Vorherrschaft einer Hemisphaere," Deutsche Medizinische Wochenschrift, LI (1925), 681-683.

<sup>3</sup> B. S. Parson, Left-handedness. A New Interpretation, pp. 51 ff. New York: The Macmillan Company, 1924.

<sup>4</sup> T. L. Woo and Karl Pearson, "Dextrality and Sinistrality of Hand and Eye," Biometrika, XIX (1927), 171-173.

<sup>5</sup> W. Ludwig, op. cit., pp. 339-347.

<sup>6</sup> Arnold Gesell, Infancy and Human Growth, pp. 367-368. New York: The Macmillan Company, 1928.

<sup>7</sup> Bethe, op. cit., p. 683.

<sup>8</sup> Charles A. Selzer, Lateral Dominance and Visual Fusion, pp. 79-81. Cambridge: Harvard University Press, 1933.

<sup>9</sup> L. E. Travis, Speech Pathology, pp. 42-45. New York: D. Appleton and Company, 1931.



the comparative use of the two hands, taking notes based on careful observation of the infant's hands during half-hour and longer periods. His results are given as follows.

3rd month: no preference for either hand.

4th and 5th months: right hand used most frequently.

6th - 11th months: no noticeable preference for either hand.

12th - 36th months: slight preference for left hand, appearing as early as the 12th month, increasing rapidly so that child was definitely left-handed by the end of the first year.....Definite training against this left-handedness was instituted and from the 16th month on, the right hand gradually was used more until by the end of the second year the child was decidedly right-handed.<sup>10</sup>

In Dearborn's record these remarks are found.

On Day 168 the baby was recorded as "very left-handed"....as volition evolved, the use of the right side gradually became more habitual and on Day 303 it is noted that she then used "the left hand and leg less readily than those of the right side."<sup>11</sup>

Miss Shinn gives her impression of the comparative use of the hands of her small niece, making the following comments.

We were satisfied that in the first weeks of grasping the left hand was more used, but I cannot establish this from my record.... After the two-handed period was fairly over, the right hand was used by preference and has been so ever since. When use of the forefinger tip for special investigation appeared, in the 10th month, it was always the right forefinger, and so too in pointing. It is my impression that it was at this time that distinct right-handedness became apparent, but my notes do not make this clear.<sup>12</sup>

Another and more recent report is that of Jessie Chase Fenton.

A baby's early preference for one hand or the other contains no implication of his later established habit in the use of the right or left hand. Usually in the very earliest grasping movements there is little or no preference for either hand; when a preference does appear it may shift several times before it settles into an established habit.....Right-handedness was apparent in my child by his 30th week, and has persisted ever since, though for a time in his 11th and 12th months the left hand came near to catching up with it.<sup>13</sup>

Experimental investigations.- Of a more scientific nature was the investigation conducted by Baldwin in 1890 when he tested his child to determine the infant's hand preference in reaching for coloured papers and other objects. The following is Baldwin's summary of the results of the experiment.

1. Found no continued preference for either hand, as long as no violent muscular exertion was made -- 6th to 10th months, inclusive.
2. The tendency to use both hands together was about double the

<sup>10</sup> Davis R. Major, First Steps in Mental Growth, pp. 43-45. New York: The Macmillan Company, 1906.

<sup>11</sup> G. V. N. Dearborn, Moto-sensory Development, p. 31. Baltimore: Warwick and York, 1910.

<sup>12</sup> Millicent Washburn Shinn, Notes on the Development of a Child, p. 324. Berkeley: University of California, 1914.

<sup>13</sup> Jessie Chase Fenton, A Practical Psychology of Babyhood, pp. 94-95. New York: Houghton Mifflin Company, 1925.



tendency to use either.

3. Distinct preference for the right hand in violent efforts in reaching was found in the 7th and 8th months.

Right-handedness had accordingly developed under pressure of muscular effort in the 6th and 7th months.<sup>14</sup>

Some years later (1910) Mrs. Woolley reported on an experiment performed by herself on her child during the infant's 7th month, in which she attempted a test of colour vision, presenting two coloured discs laid side by side in front of the infant. The hand used in picking up the disc and also the position of the disc were recorded.

The difference in the use of the right and left hands for the entire series is not great enough to be significant, but it is interesting to note that the days on which the use of the left hand predominated, were all, with one slight exception, during the first week of the month....but after that, the right hand predominated steadily.<sup>15</sup>

Mrs. Woolley then gave a series of informal tests with objects at varying distances away from the infant and found a preference for the use of the right hand for reaching, supporting Baldwin's findings. She also made note of the use of the hands after the beginning of the 8th month, finding no evidence of handedness during the 7th and 8th months, but concluding that right-handedness was apparent in ordinary activities by the end of the 9th month.

An interesting point made by Mrs. Woolley in connection with the colour-disc series was that although the child did not (The whole series taken together) show preference for either hand, he did show a preference for the right side position, choosing that position 285 times to 183 times for the left side position. The following comment is made by Mrs. Woolley.

The preference for the right-hand position in excess of that for the use of the right hand, suggests a query as to whether the eyes could play a role in the development of right-handedness, but the query is scarcely worth making so long as the observation is an isolated one.<sup>16</sup>

Watson also contributed a report on handedness in infancy, having made a study of a group of infants during the first ten days of life, with the following results.

1. Measurements of right and left anatomical structures....no significant difference in the right and left measurements.
2. Recording the time of suspension with left and right hand ....no constancy in time of suspension from day to day.
3. Recording approximately the total amount of work done with right and left hands for a given period of time....little significant difference between the work of the two hands.<sup>17</sup>

Watson undertook, further, an investigation of the use of the hands in reaching, testing twenty infants from 150 days to one year of age. The subjects were tested to determine which hand would be first used in reaching

<sup>14</sup> J. Mark Baldwin, Mental Development in the Child and the Race, Methods and Processes, p. 65. New York: The Macmillan Company, 1895.

<sup>15</sup> Helen Thompson Woolley, "Development of Right-handedness in a Normal Infant," Psych. Rev., XVII (January, 1910), 37.

<sup>16</sup> Ibid., p. 41.

<sup>17</sup> John B. Watson, Behaviorism, pp. 130-131. Revised; New York: W. W. Norton and Company, 1930.

for objects, the test occurring once each week, with ten to twenty trials in each series. An object (stick of peppermint candy) was brought slowly toward the face of the infant and records were taken of the hand first used, and if both hands, which hand touched the object first. No predominant use of either hand was found, according to Watson.

This investigator, then, considered the matter closed, stating, "the main problem is, I believe, settled: handedness is not an 'instinct.' It is possible not even structurally determined. It is socially conditioned." 18

Perhaps the most detailed study of hand preference in infancy was conducted by Ernst Voelckel at the University of Munich in 1911.<sup>19</sup> This investigator tested 52 children, aged 3½ to 17 months, to determine which hand is most frequently used in reaching for objects. The infant, lying on his back, was presented with an object held within reaching distance and so situated as to be equally distant from the two hands. It was noted with which hand the infant reached for the object. The tests were extended over a period of several days until a satisfactory number of trials could be secured, approximately fifty for each subject.

Voelckel's data show no difference in the use of the right and left hands earlier than seven months of age, with increasing differentiation from that time on.

On the basis of this study and that of Baldwin, mentioned earlier, Ludwig makes the following definite statement concerning the time at which hand preference sets in.

In the new-born children hand preference begins during the seventh month at the earliest. Until that time children are ambidextrous....and from that time, only, is there gradually built up a preference for one hand.<sup>20</sup>

An earlier age, however, is suggested by Lippman, who found in his investigation of acceptance of objects by infants, that "at 4½ months the right and left hands are used with the same frequency. From this time to twelve months there is a gradual increase in the tendency to use the right hand, culminating in a 70 + % use of the right hand at 12 months." 21

Halverson, on the basis of his study of prehension in infants, states that "hand preference in touching the cubes alternates with age up to 36 weeks and then favors the right hand at 40 weeks and remains with this hand at 52 weeks." 22

#### Object of the Present Study

There is, then, considerable uncertainty both as to the nature of hand preference and as to its first appearance in infancy. According to Anderson, "despite the extensive literature on the subject, there have been relatively few adequate surveys of the development of handedness in young children, and at the present time little can be said with reference to the

<sup>18</sup> Ibid., p. 134.

<sup>19</sup> Ernst Voelckel, "Untersuchungen über die Rechtshändigkeit beim Säugling," *Zeitschrift für Kinderheilkunde*, VIII (1913), 351-358.

<sup>20</sup> Ludwig, *op. cit.*, pp. 289-290.

<sup>21</sup> H. S. Lippman, "Certain Behavior Responses in Early Infancy," *Ped. Sem.*, XXXIV, 438-439.

<sup>22</sup> H. M. Halverson, "An Experimental Study of Prehension in Infants by Means of Systematic Cinema Records," *Genet. Psych. Monog.*, X (1931), 211.

origin of handedness or its frequency in young children." <sup>23</sup> Miss Updegraff, working with children aged two to five years, found evidence of such definite hand preference among the youngest children in her experimental group that she comments upon the need for investigation at earlier age levels.<sup>24</sup>

That there is a gap in the literature on hand preference at the beginning age period is undoubtedly true, and that filling in this gap might do much to clear up the problem of the nature of hand preference seems obvious. With this object in view, namely, to attempt to discover the earliest manifestations of differentiation between the two hands, the following investigation was undertaken.

<sup>23</sup> John E. Anderson, "The Development of Motor, Linguistic and Intellectual Skills in Young Children," Conference on Research in Child Development, University of Toronto, 1929, pp. 153-154. Issued by Committee on Ch. Dev., Nat. Research Council, Washington, D. C.

<sup>24</sup> Ruth Updegraff, "Preferential Handedness in Young Children," J. Exp. Education, I (December, 1932), 139.

## CHAPTER II

### PRELIMINARY INVESTIGATION

Although Watson, in his study of the first ten days of infancy, found no difference in the amount of activity of the two hands, it seemed reasonable to assume that whatever differentiation could occur in early infancy must find expression in the infant's spontaneous movements. For this reason, a preliminary study of a group of older infants was undertaken to determine whether or not there is a difference in the amount of activity of the two hands, and, if so, whether or not there is a relationship between amount of activity and preferential use of the hands.

#### Subject Group

Four children, two boys and two girls, were used as subjects in this preliminary investigation.

Subject 1, Frances, was observed for a period of six months, the observations beginning during her eighth month and continuing through her fourteenth month.

Subject 2, Cecil, was observed for a period of three months, beginning during his fourteenth month and continuing through his seventeenth month.

Subject 3, John William, was observed for a period of two months, from his ninth to his eleventh month, and again during his thirteenth month.

Subject 4, Virginia, was observed very intermittently from her seventh to her eleventh month.

All four of these subjects are children of exceptionally good parentage. Subject 1's father is an instructor in the University of Chicago, Subject 2's father is an instructor at Loyola University, Subject 3's father is a practicing lawyer in the city of Chicago, and Subject 4's father is a graduate student in the University of Chicago. The mothers are educated, intelligent women, and the children in all cases are first-born, only children, normal, healthy and well-developed physically.

#### Method of Procedure

Observational situation.- All observations were made in the homes of the subjects, and a friendly relation between the experimenter and the child was quickly established so that during practically all observations the subjects were contented and spontaneously active. It was the object of the experimenter to study the children in their normal milieu.

The hour of the observation was always arranged to fit into the child's schedule, taking place during his regular play time. Toward the end of the observations of Subjects 1 and 2, the observations were systematically alternated mornings and afternoons in order to determine whether or not the time of day might influence the outcome.

Test routine.- The following routine was carried out in each observation period.

1. Spontaneous manipulative activities of the hands were timed for a period of six minutes.
2. One object presented, placed on the table in the median plane, about ten inches in front of the child -- ten presentations of the object.



3. Second six-minute period of timing of spontaneous manipulative activities.

4. Two objects presented, placed on the table, one in line with each arm, about ten inches in front of the child -- three to five presentations of the object.

5. One object presented in the hand of the experimenter, held in the median plane just above the table top, about ten inches in front of the child, the experimenter's hands alternating right and left -- ten presentations of the object.

6. Third six-minute period of timing of spontaneous manipulative activities.

7. For Subjects 1 and 2, during the early observations, one object was presented alternately right and left, placed on the table about ten inches in front of the child -- usually five presentations in each position.

8. During later observations of all four subjects, records were taken of the hand used in spontaneous picking up of objects during free play.

Details of procedure.-- During the first few observations of Subjects 1 and 2, before the routine was definitely established, Part 5 above (one object in the hand of the experimenter) was omitted, and in Part 2 (one object placed medianly on the table) only five opportunities for reaching were allowed. After the program was definitely settled upon, however, it was followed systematically, with the exception that occasionally Part 4 (two objects presented at once) had to be omitted because of limited time or lack of interest on the part of the child. As indicated above, Part 7 (one object alternated right and left) was not included in the routine for Subjects 3 and 4, and Part 8 (hand used in picking up objects) was added some time after the beginning of the observations.

During all except the last two or three observations of Subjects 1, 2 and 3, the infants were seated in high chairs for the presentation of objects, and either in the high chair or in the play pen for the timing of spontaneous activity of the hands. Toward the end of the experimental series it became difficult to keep the children in the high chair since by that time they had outgrown this situation. Subject 2 happened to be a more docile and less active child than the other three, and for this reason could be inveigled to remain in the high chair (therefore the experimental situation) at a later age than could the other subjects. Observations of Subject 4 were less systematic and therefore less satisfactory than were those of the other three members of this experimental group.

A piece of presswood, 19" x 24", hollowed out on one side to allow the body of the child free movement, yet fitting closely enough to insure consistency in the position of the child in relation to the board, was fastened on the tray of the high chair to serve as a table. Lines drawn on this improvised table served to guide the experimenter in placing the objects before the child accurately and quickly.

As much of the time as possible, the object presented to the children was a one inch square, bright-colored block. Occasionally other objects were substituted because of loss of interest in the blocks, but in all cases the objects were of a shape and size so that they could conveniently be held in the child's hand -- a small rubber ball, for example, or a small rubber dog, and on a few special occasions, even the experimenter's stop watch. Whenever two objects were presented at once, they were identical in appearance so that no individual characteristics of the objects could enter into the situation to influence the child's reaching activities.

When the child was seated in the high chair during the timing of spontaneous manipulative activities, toys were placed upon the table freely so that they were easily accessible to either hand. When the observations were of the child's activity in the play pen, the customary toys were again at hand. Always, during the timing of spontaneous manipulative activity, the object of the experimenter was to observe the child in a normal play situation. In this way records of the child's preferential use of the hands in a controlled experimental situation could be compared with records of the spontaneous use of the hands in an uncontrolled situation.

The following method was employed in timing the spontaneous manipulative activities. During each six-minute timing period, the hands were observed alternately for one minute at a time. The one-minute interval was timed with one stop watch and the length of time during which the hand under observation was active during that minute was timed with another and cumulative stop watch. Results were recorded at the end of each one-minute interval. Recording of results was done very quickly so that the six one-minute observations of the hands could follow one another as smoothly as possible and thus give comparable samplings of the activity of each hand for the total observation period.

In the controlled experimental situation, results were recorded in terms of the number of times the right, left, and both hands together were used to secure the object presented.

### Results

Subject 1, comparative use of the hands in reaching for objects in the controlled experimental situation.- This subject, who was tested from seven and one-half to fourteen months of age, was found to use the right hand significantly more than the left hand during the first month of the testing period, i.e., from November 21st to December 15th.

When the tests were resumed on January 23rd, however, the subject was found to be no longer right-dominant, but rather to be using both hands with about equal frequency. Since no tests had been taken from December 15th to January 23rd, it is impossible to say when this non-dominant stage had its beginning, but within three days of the resumption of testing, non-dominance shifted to left-dominance, and from January 26th to February 17th, the child was definitely left-dominant.

Succeeding this left-dominant period, during the tests given from February 17th to February 27th, another non-dominant or, perhaps, transitional stage occurred, in which neither hand retained the ascendancy. By February 27th, however, the right hand was again dominant and this hand retained the lead through May 31st, the end of the test series.

Fig. 1 gives the results of the tests involving the presentation of one object in the median plane on the table, combined with the results of the presentation of one object in the hand of the experimenter (methods 2 and 5 of the test routine), and clearly indicates the changes from right to left and back to right-dominance. For convenience in discussion and to assist in the analysis of the results, these three distinct phases are labeled Periods I, II, and III in the figure and also in Table I, which gives the results for all the reaching situations in terms of percentages, both for the test series as a whole and for the three periods, separately. No fine method of delineating the periods was used in this part of the investigation, simple inspection of the reaching results as shown in Fig. 1 determining the three divisions.

That there was a definite change in the child's behavior patterns during the left-dominant stage, Period II, with respect to the use of her hands, was attested to by her mother who said the child was now using her left



TABLE I

SUBJECT 1, USE OF THE RIGHT, LEFT AND BOTH HANDS IN REACHING FOR OBJECTS IN THE SEVERAL TEST SITUATIONS, SHOWING THE RESULTS WHEN THE TEST SERIES IS DIVIDED INTO THREE PERIODS ON THE BASIS OF SHIFTS IN HAND DOMINANCE AND ALSO SHOWING THE TEST SERIES AS A WHOLE

| Period            | Test Situation                  | Hand Used |          |          | No. Trials |
|-------------------|---------------------------------|-----------|----------|----------|------------|
|                   |                                 | Right (%) | Left (%) | Both (%) |            |
| I<br>Rgt.-dom.    | One object medianly on table... | 75        | 9        | 16       | 55         |
|                   | One object alternated R and L.. | 58        | 29       | 13       | 48         |
|                   | Two objects at once.....        | 54+       | 41       | 4+       | 66         |
| II<br>Lft.-dom.   | One object medianly on table... | 25        | 51       | 22       | 180        |
|                   | One object alternated R and L.. | 38        | 54       | 8        | 142        |
|                   | Two objects at once.....        | 46        | 53       | 1        | 134        |
|                   | One obj. presented in E's hand. | 24        | 50+      | 25+      | 180        |
|                   | Objects picked up.....          | 42        | 58       | -        | 577        |
| III.<br>Rgt.-dom. | One object medianly on table... | 80        | 14       | 4        | 130        |
|                   | One object alternated R and L.. | -         | -        | -        | -          |
|                   | Two objects at once.....        | 50        | 50       | -        | 64         |
|                   | One obj. presented in E's hand. | 77        | 18       | 4        | 130        |
|                   | Objects picked up.....          | 54        | 46       | -        | 743        |
| Total Series      | One object medianly on table... | 52        | 32       | 15       | 365        |
|                   | One object alternated R and L*. | 43        | 48       | 9        | 190        |
|                   | Two objects at once.....        | 49+       | 49+      | 1+       | 264        |
|                   | One obj. presented in E's hand# | 46        | 36+      | 17+      | 320        |
|                   | Objects picked up#.....         | 49        | 51       | -        | 1320       |

\* No records for Period III.

# No records for Period I.

hand even for picking up small crumbs from the tray of her high chair while formerly her right hand had been used much more frequently both for reaching and for picking up objects.

Looking at Table I, it is to be noted that the summation of the results of the entire test series for Subject 1, in terms of percentages, indicates a significant difference in favor of the right hand in reaching for one object, in spite of the left-dominant period, both when the object was placed on the table and when it was presented in the experimenter's hand. The favoring of the right hand is not so great in the second as in the first of these two test situations, but this is probably due to the fact that no records were secured for the presentation of an object in the experimenter's hand during Period I, a right-dominant period.

The total results for the use of the hands in picking up objects seems also to be affected by the lack of records during Period I. The other two periods practically balance one another, with the result that the final outcome indicates no difference between the two hands for this activity. Similarly, the final result favoring the left hand in the case of the presentation of one object alternately right and left is no doubt due to the lack of records during Period III.

In the case of the presentation of two objects at once, the favoring of

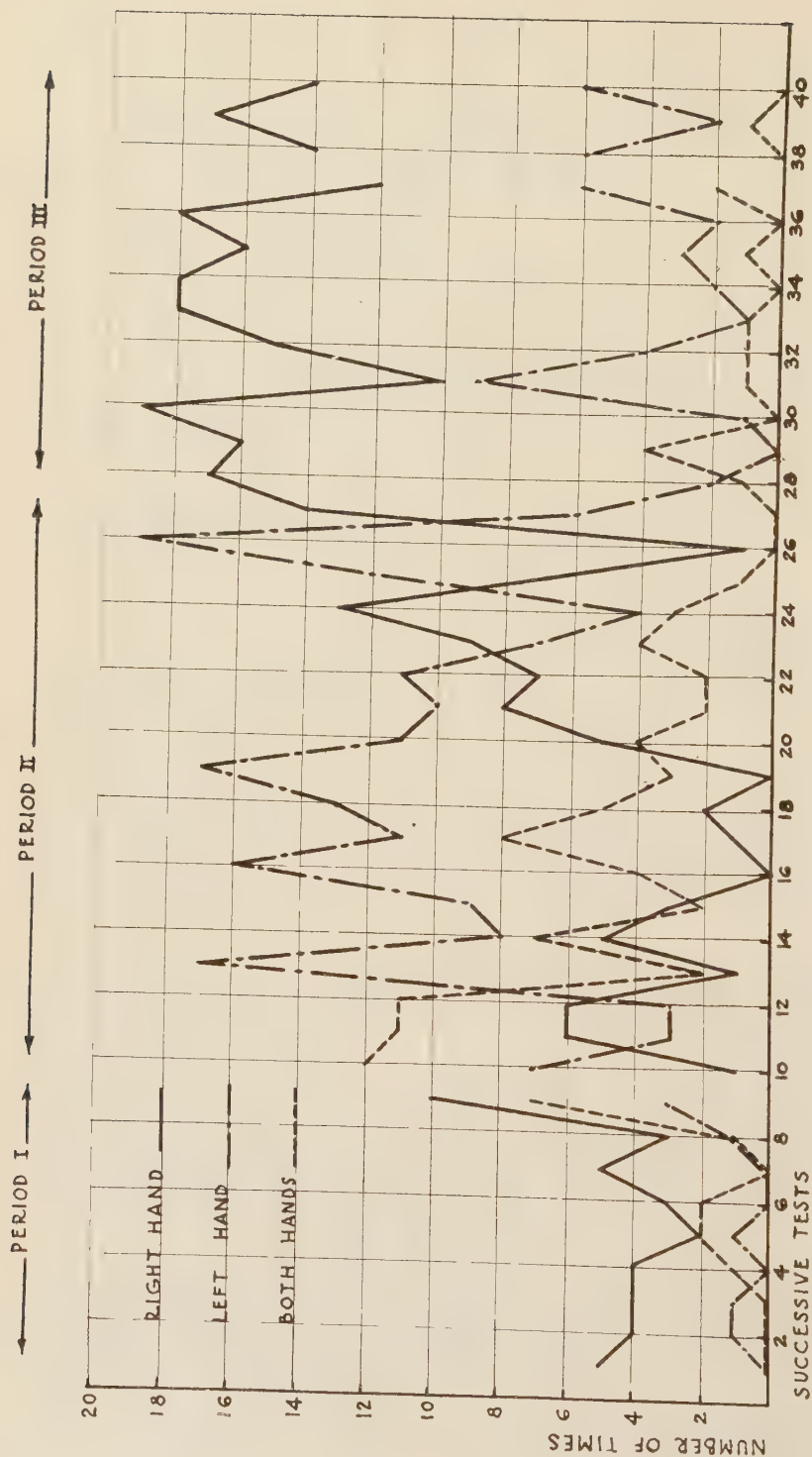


Fig. 1 - Subject 1 total number times hands used in reaching for objects in controlled experimental situation. Periods refer to shifts in hand dominance. Intervals indicate considerable time elapsed between tests.

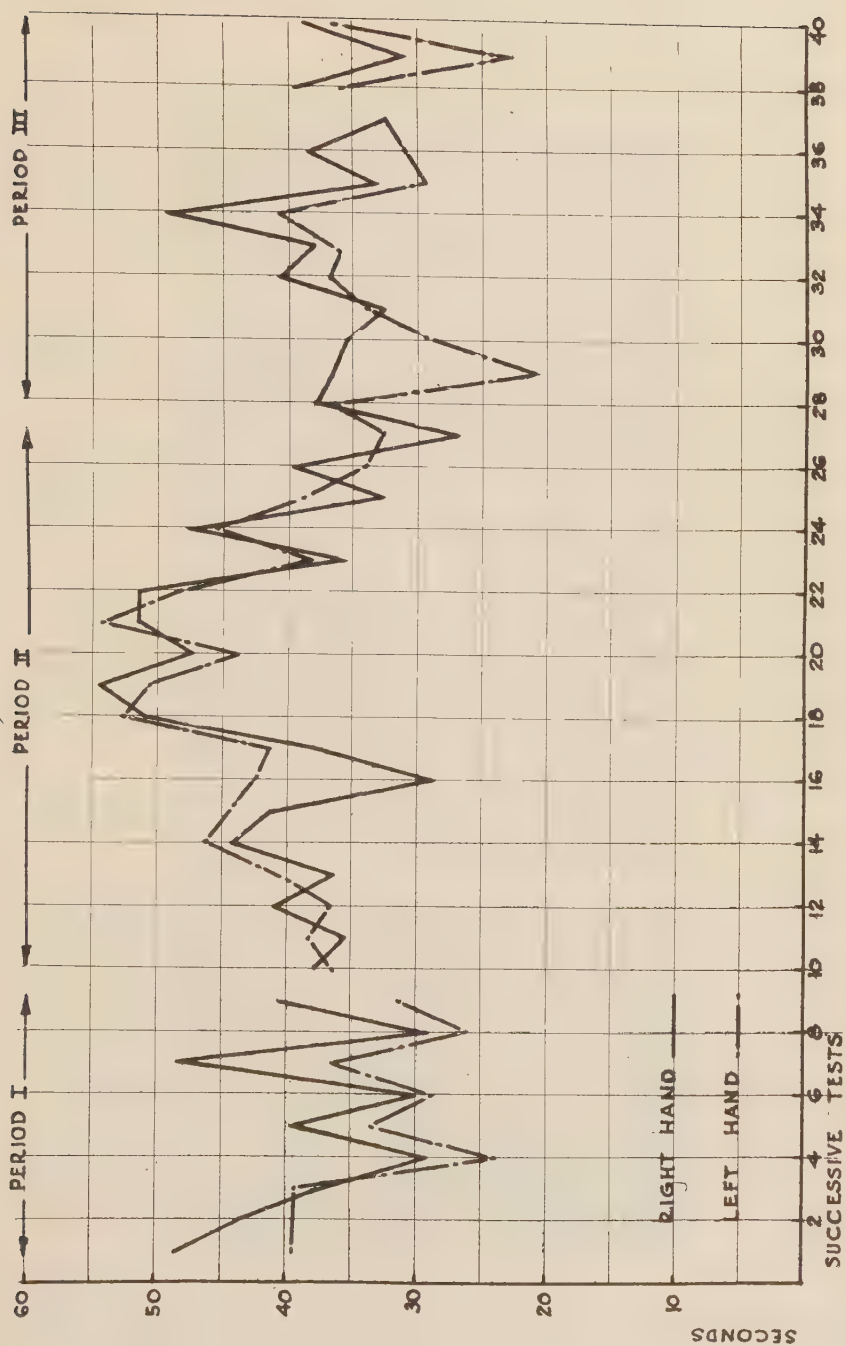


Fig. 2 - Subject L, average amount per minute spontaneous activity of hands in manipulating objects during free play. Periods refer to shifts in hand dominance. Intervals indicate considerable time elapsed between tests.

the right hand during Period I and of the left hand during Period II is significant because of this shift, even though the actual differences are not great. Since they disappear altogether in Period III, it is to be expected that for the total series no difference between the use of the two hands in this situation will appear.

A possible explanation of this disappearance of a favoring of one or the other hand, when two objects were presented at once, might lie in the tendency observed by the experimenter toward a shift, with advancing age, from the use of one hand, alone, to secure one of the two objects presented, ignoring the other object, to the use of both hands at once to secure the two objects, one in each hand. Some experimental evidence of this is found in the record of Subject 1 as analysed in Table I, in which it is shown that the use of both hands on one object, when two objects are presented at once, is reduced from 44% in Period I, to 1% in Period II, and finally does not enter at all in Period III.

Subject 1, comparative activity of the hands in spontaneous manipulation of objects.— Results of the timing of spontaneous manipulative activity of the two hands of Subject 1 show consistent differences favoring one or the other hand, bearing a close relationship to the differences in the use of the hands in reaching for objects in the controlled situation. Fig.2 gives the average amount per minute of spontaneous manipulative activity of the hands for each successive day's testing. Comparison of Figs. 1 and 2 shows the general agreement, in the favoring of one or the other hand, between the daily records for reaching for objects in the controlled experimental situation and for spontaneous manipulation of objects.

The record of spontaneous manipulative activity (Fig.2) is arbitrarily divided into periods corresponding to those shown in Fig. 1, and while it may be noted that the transitional phases, i.e., those series of tests in which neither hand was dominant and which begin and close Period II, are longer, and the actual left-dominant phase is shorter in the case of spontaneous manipulative activity than in the case of reaching for objects, the same shifts in dominance are present, and, except for the difference noted, occur at the same time.

It should be further noted that relatively small differences in spontaneous activity of the hands accompany quite large differences in the preferential use of the hands.

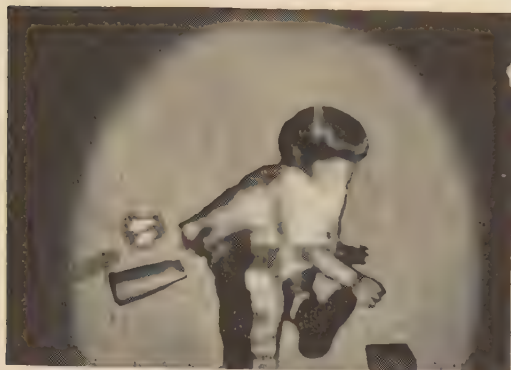
Later developments suggested to the experimenter that timing of spontaneous hand movement gives a more satisfactory representation of spontaneous manual activity than does timing of spontaneous manipulation of objects, alone. Manipulation, i.e., active use of the hand in contact with some object such as a toy, the table top, chair arm, dress, other parts of the body, etc., was first chosen as the criterion of activity because it was thought that judgment of this type of manual action would be freer from error than would judgment of general movement. It became obvious, however, that the less active and less preferred hand is the hand most often used for support in a forward-lying, sitting or standing position. See Plates I, IV, and VI. Since use of the hand for support, when the supporting involved holding onto something, was considered a manipulative activity, the recorded differences in activity between the two hands were smaller than they would have been had movement rather than manipulation been the criterion.

The family history of Subject 1 gives no known cases of left-handedness.

Subject 2, comparative use of the hands in reaching for objects in the controlled experimental situation.— In the case of Subject 2, who was tested from fourteen to seventeen months of age, the left hand was used significantly more than the right hand throughout the test series.

## PLATE I

SUBJECT 1, SIXTEEN MONTHS OF AGE, RIGHT DOMINANT



Right hand reaching far over toward left side  
to secure block. Left hand supporting weight.



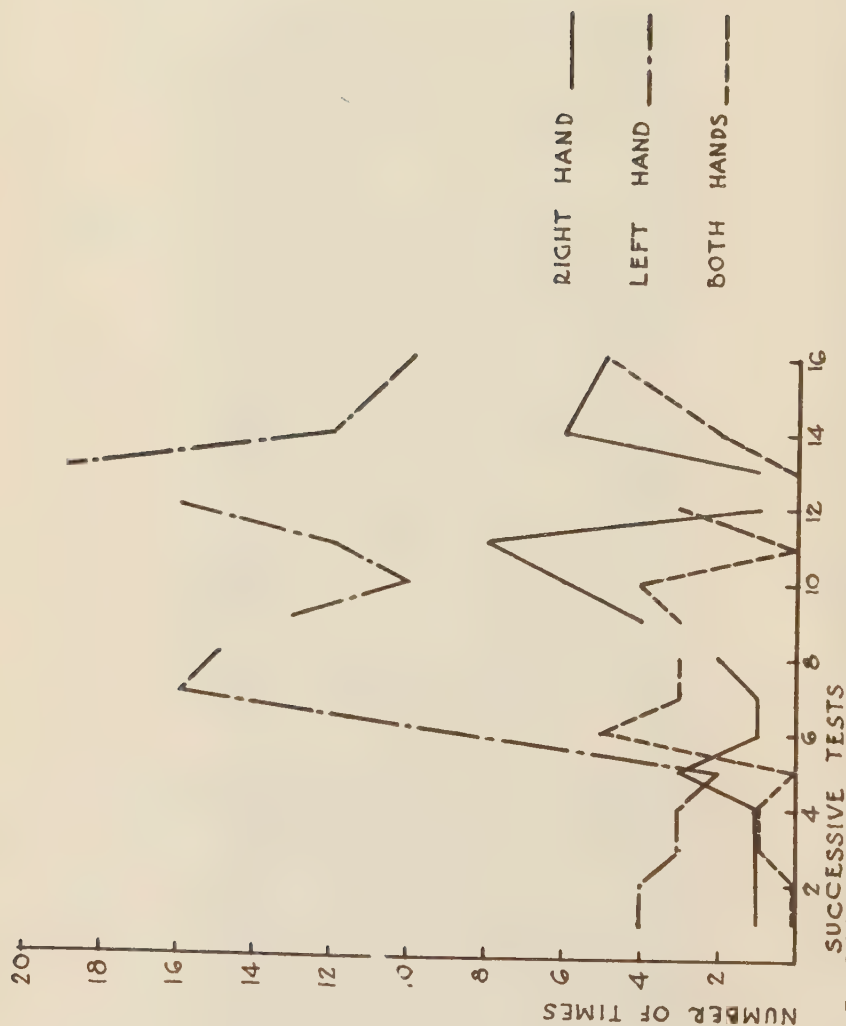


Fig. 3 - Subject 2, total number times hands used in reaching for objects in controlled experimental situation. Intervals indicate considerable time elapsed between tests.

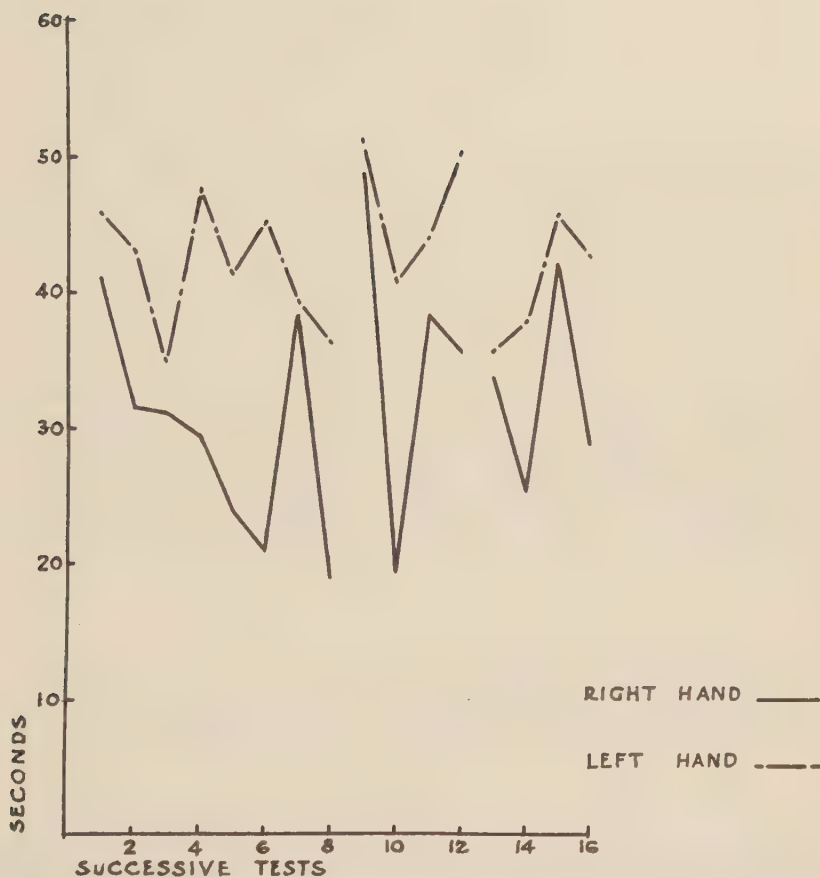


Fig. 4 - Subject 2, average amount per minute spontaneous activity of hands in manipulating objects during free play. Intervals indicate considerable time elapsed between tests.

Fig. 3 shows the successive daily records of the use of the hands in reaching for objects in the controlled situation, based on the combined results of the two test situations in which one object was presented medianly to the child, methods 2 and 5 of the test routine (object presented on the table, and object presented in E's hand). The records for this subject in these two situations are not so similar as is the case with Subject 1, Subject 2's right hand apparently benefiting somewhat from the presentation in the experimenter's right hand. The two records are thrown together, however, in order to increase the size of the sampling of the use of the hands in reaching for an object presented medianly in front of the child.

As has been mentioned before, the records for the earlier observations include only half as many trials as do those for the later periods, which accounts for a large part of the apparent increase in the use of the left hand, as indicated in the figure. Some real increase in the use of the left hand, however, seems to be present, accompanied by a slight decrease in the use of the right hand, through the test series. The extent of the use of both hands, together, seems fairly stable.

It is interesting to note in Table II, which shows the comparative use of the hands of Subject 2, in terms of percentages, for all of the test situations, that this subject used the left hand to such an extent that even the results of presenting an object alternately right and left show a significant favoring of the left hand. When two objects are presented at once, however, both hands go into action, one to secure each object, as was the case in Period III for Subject 1, giving additional evidence that this type of behavior represents a more mature level of manual skill. Notes taken during the observations of Subject 2 indicate even here, however, a preference for the left hand expressed in a tendency for the left hand to reach for the object on the left side before the right hand reached for the object on the right side.

TABLE II

SUBJECT 2, USE OF THE RIGHT, LEFT AND BOTH HANDS IN REACHING FOR OBJECTS IN THE SEVERAL TEST SITUATIONS, SHOWING THE RESULTS FOR THE TEST SERIES AS A WHOLE

| Test Situation                    | Hand Used |          |          | No. Trials |
|-----------------------------------|-----------|----------|----------|------------|
|                                   | Right (%) | Left (%) | Both (%) |            |
| One object medianly on table....  | 14        | 76       | 10       | 125        |
| One object alternated R and L.... | 38        | 54       | 8        | 100        |
| Two objects at once.....          | 47+       | 51       | 1+       | 74         |
| One obj. presented in E's hand..  | 28        | 54       | 18       | 100        |
| Objects picked up.....            | 18        | 82       | -        | 385        |

It was characteristic of this older child to make a game of reaching for objects. The object, when secured, would be handed at once to the experimenter, and it seemed to be this game element which held the interest of the child in reaching for the objects. In the cases of the younger children, the objects were reached for in order to carry them to the mouth or to manipulate them with the hands.

Toward the latter part of the test series for Subject 2, paper and pencil were placed before the child, and it was noted that the pencil was invariably used with the left hand. If taken up in the right, it would be transferred to the left for use. The mother contributed the information that the child could screw the cap onto a toothpaste tube if the tube were

given to him in his right hand and the cap in his left, whereas if the two objects were presented to him the other way, the tube into the left and the cap into the right hand, he seemed entirely at a loss as to what to do with them.

Inquiry into the family history brought out the fact that Subject 2's grandmother and one uncle were considered to be ambidextrous, and another uncle definitely left-handed. All three of these cases were on the father's side of the family.

No influence of the time of day at which the tests were carried out was found for either Subject 1 or Subject 2.

Subject 2, comparative activity of the hands in spontaneous manipulation of objects.- Results of the timing of spontaneous manipulative activities for Subject 2 consistently favor the left hand through the test series. Fig. 4 shows the average amount per minute of spontaneous manipulative activity of the hands of this subject for successive tests, and Figs. 3 and 4, compared, indicate the relationship between these results and the results of the presentation of one object to the child in the controlled experimental situation.

Differences between the spontaneous activity of the hands of this subject are greater than the differences in the activity of the hands of Subject 1. This is also true of the differences in the use of the hands for reaching, when the entire test series of Subject 1 is taken as a whole, and indicates that Subject 2 is more left-handed than Subject 1 is right-handed. This is in agreement with the experimenter's general impression of the two children. However, if only Period III is taken into account for Subject 1, the two cases are quite similar, and since the age of Subject 1 at the time of the last period of testing is more comparable than during the earlier periods, to that of Subject 2, it might be justifiable to assume that Subject 1 is becoming equally as right-handed as Subject 2 has become left-handed.

Subject 3, comparative use of the hands in reaching for objects in the controlled experimental situation.- Subject 3, tested from approximately eight and one-half to eleven months of age, and again during his thirteenth month, is a definitely right-dominant child.

Somewhat as in the case of Subject 1, a phase of right-dominance is followed by a phase during which the left hand seems to be used at least as much as the right hand. This is, in turn, followed by a resumption of right-dominance. Fig. 5 shows the daily records of the use of the hands in reaching for an object placed on the table in front of the child, combined with the records for reaching for an object presented in the experimenter's hand. Analysis of the figure indicates a period of right-dominance, followed by a period of non-dominance, which is in turn followed by another period of right-dominance. These phases are labeled Periods I, II and III, simply on inspection of the figure.

Table III gives the results for the several test situations for this subject in terms of percentages, showing the three periods separately and also the test series as a whole. It will be seen that while the results for the entire test series, taken as a whole, all favor the right hand, during Period II the left hand more nearly equalled the right in two of the test situations, namely, when one object was presented on the table and when two objects were presented at once, than was the case during Periods I and III, while the left actually superseded the right hand in Period II when one object was presented in the experimenter's hand. Records of the hand used to pick up objects during free play show no significant difference between the two hands in Period II, which is in distinct contrast to the favoring of the right hand for this activity in both the period.

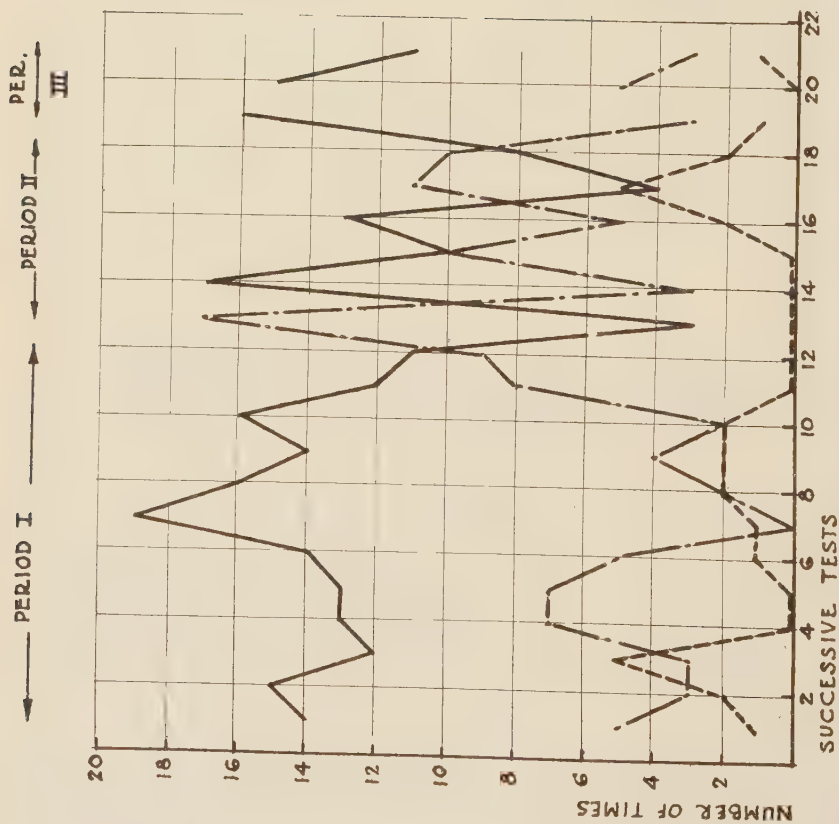


Fig. 5 - Subject 3, total number times hands used in reaching for objects in controlled experimental situation. Periods refer to shifts in hand dominance. Interval indicates considerable time elapsed between tests.



TABLE III

SUBJECT 3, USE OF THE RIGHT, LEFT AND BOTH HANDS IN REACHING FOR OBJECTS IN THE SEVERAL TEST SITUATIONS, SHOWING THE RESULTS WHEN THE TEST SERIES IS DIVIDED INTO THREE PERIODS ON THE BASIS OF SHIFTS IN HAND DOMINANCE AND ALSO SHOWING THE TEST SERIES AS A WHOLE

| Period               | Test Situation                   | Hand Used |          |          | No. Trials |
|----------------------|----------------------------------|-----------|----------|----------|------------|
|                      |                                  | Right (%) | Left (%) | Both (%) |            |
| I<br>Rgt.-<br>dom.   | One object medianly on table.... | 76        | 12       | 13       | 120        |
|                      | Two objects at once.....         | 65        | 28       | 7        | 46         |
|                      | One obj. presented in E's hand.. | 64        | 33       | 3        | 120        |
|                      | Objects picked up.....           | 61        | 39       | -        | 391        |
| II<br>Non-<br>dom.   | One object medianly on table.... | 50        | 38       | 12       | 50         |
|                      | Two objects at once.....         | 53        | 42       | 5        | 19         |
|                      | One obj. presented in E's hand.. | 46        | 54       | -        | 50         |
|                      | Objects picked up.....           | 48        | 52       | -        | 153        |
| III<br>Rgt.-<br>dom. | One object medianly on table.... | 69        | 25+      | 5-       | 55         |
|                      | Two objects at once.....         | 75        | 25       | -        | 8          |
|                      | One obj. presented in E's hand.. | 60        | 35       | 5        | 20         |
|                      | Objects picked up.....           | 65        | 35       | -        | 43         |
| Total<br>Series      | One object medianly on table.... | 69        | 21       | 10       | 225        |
|                      | Two objects at once.....         | 63        | 32       | 5        | 73         |
|                      | One obj. presented in E's hand.. | 59        | 39       | 2        | 190        |
|                      | Objects picked up.....           | 58        | 42       | -        | 589        |

preceding and the one following it.

These shifts in manual activity pattern for this child, while not so extreme as in the case of Subject 1, were yet quite striking and were also commented upon by the child's mother.

Subject 3, comparative activity of the hands in spontaneous manipulation of objects.- Results of the timing of spontaneous manipulation of objects during free play in the case of Subject 3, as shown in Fig. 6, give phases comparable to those indicated in the use of the hands in reaching for objects in the controlled experimental situation. Comparison of Figs. 5 and 6 show the relationship between the two types of results.

By the time the last two tests of Subject 3 were carried out, the experimenter had determined that timing of movement of the hands serves as a more adequate criterion of activity than does timing of manipulation, only, and these last two records are therefore records of spontaneous movement of the hands.

Again the results indicate a close relationship between differences in amount of spontaneous activity of the two hands in free play and differences in the use of the hands in reaching for objects in the controlled experimental situation.

The family history in the case of Subject 3 gives no known cases of left-handedness.

Additional comparison of Subjects 1 and 3.- It will be noted in the case of Subject 3 that when the results are presented as in Fig. 5, the

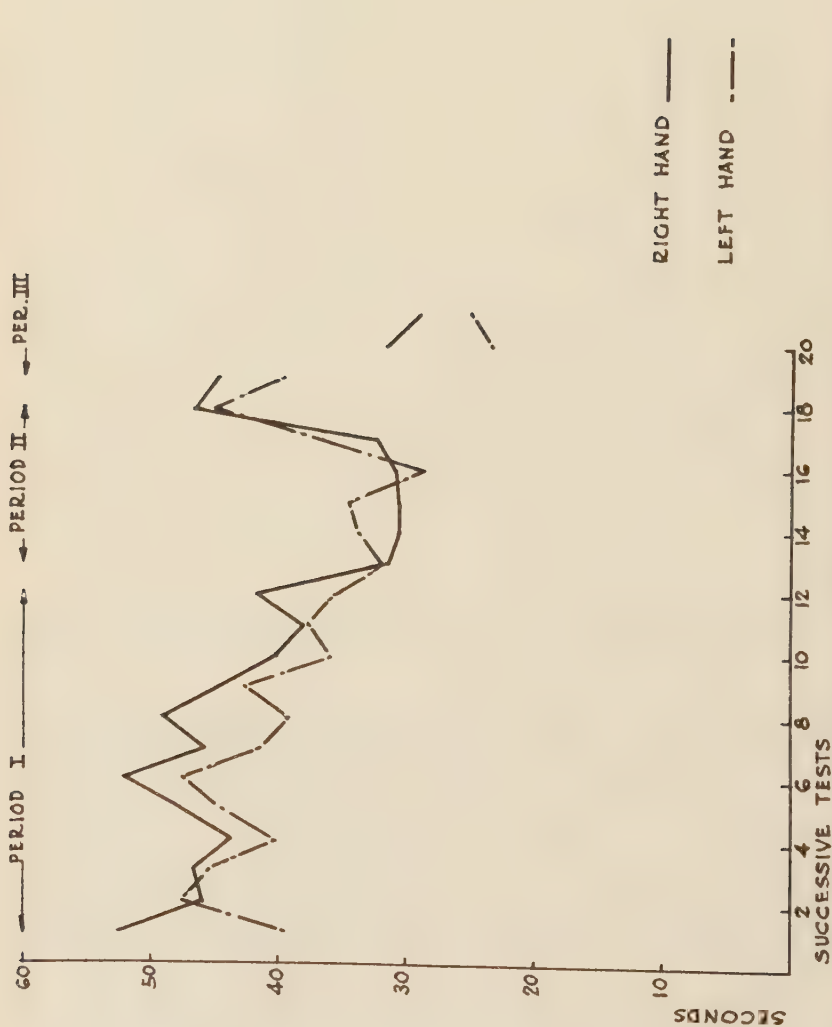


Fig. 6 - Subject 3, average amount per minute spontaneous activity of hands in manipulating objects during free play. Periods refer to shifts in hand dominance. Interval indicates considerable time elapsed between tests.

left hand is found never really to have superseded the right, as was the case with Subject 1, nor does Period II last so long for the former as for the latter subject. Some of the difference between the two cases is due to the fact that Subject 1 was tested three times per week during this middle phase, while Subject 3 was tested only twice per week. Subject 1's temporary "left-dominance" thereby had a greater opportunity than Subject 3's to show itself in the records.

The actual length of Period II, however, is different for the two subjects, Subject 1's second period lasting at least forty days, perhaps longer if the beginning of the period had been definitely established, while Subject 3's second period lasted only eighteen days. This, in itself, seems to indicate that the fluctuation was less acute in the case of Subject 3 than of Subject 1.

It seems important to note, also, that the age at which this fluctuation appears is approximately the same in the two cases. For subject 1, Period II began during the latter part of the ninth month and extended almost to the end of the tenth month, while for Subject 3 this period started soon after the beginning of the tenth month and extended almost to the end of the tenth month.

It is, of course, impossible to say what the pattern of the activity of Subject 3's hands may have been during the months from May 17th to August 2nd, throughout which time no tests were given. Unfortunately, the family left the city for a vacation at this time, and no records could be secured. The right hand had regained its ascendancy before the tests were interrupted, however, and the mother agreed to make note of any indications of a change in this situation, during the vacation period. Her report, on returning, was that so far as she could tell the right hand maintained the dominant position. It seems justifiable, therefore, to assume that the right hand did really remain the dominant hand throughout the time interval included in Period III.

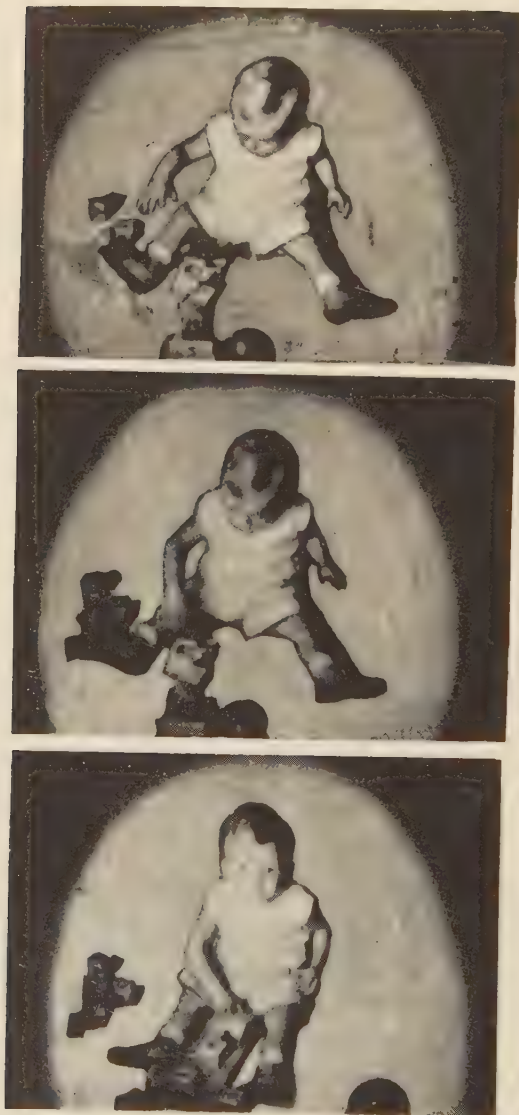
The experimenter's general impression of the two children, Subjects 1 and 3, is that they were quite similar in development, which suggests the possibility of a fairly definite periodicity in lateral dominance, since fluctuations occurred at approximately the same age periods in the two cases. Furthermore, the impression gained from observing the two children was that Subject 3 was more right-dominant than Subject 1. This impression may have little reliability, but the thought suggests itself that greater periods of fluctuation may accompany less marked dominance of one side of the body.

Subject 4, comparative use of the hands in reaching for objects in the controlled experimental situation.- As has been stated, tests of Subject 4 were very intermittent and were not conducted in a sufficiently controlled situation to be reliable. The subject was seated in her high chair only twice, and objects placed presumably in the median plane before her may or may not have been so placed on all the occasions when she was not seated in the high chair.

The results for this subject might have been omitted were it not for the fact that the parents of the child considered her to be practically ambidextrous, and, as far as the records have any value, the right-hand preference indicated is certainly less marked than that shown by Subjects 1 and 3. The case, therefore, makes some contribution to the problem of degrees of hand preference.

Here is a child who is splendidly developed in every way and whose manual skill is quite equal to that of the other three subjects dealt with in this investigation, but who seems to show a much less distinct dominance of one hand over the other than is shown by the other children.

## PLATE II

SUBJECT 3, THIRTEEN MONTHS OF AGE, RIGHT DOMINANT

About to pick up object with right hand, but hears sound of camera and begins scratching box with finger of right hand. Left hand motionless.

Fig. 7 gives the combined successive daily records of the use of the hands in reaching for an object presented medianly on a table or on the floor in front of the child, and the use of the hands in reaching for an object presented in the experimenter's hand. Table IV gives the comparative use of the hands in the several test situations in terms of percentages.

TABLE IV

SUBJECT 4, USE OF THE RIGHT, LEFT AND BOTH HANDS IN REACHING FOR OBJECTS IN THE SEVERAL TEST SITUATIONS, SHOWING THE RESULTS FOR THE TEST SERIES AS A WHOLE

| Test Situation                  | Hand Used |          |          | No Trials |
|---------------------------------|-----------|----------|----------|-----------|
|                                 | Right (%) | Left (%) | Both (%) |           |
| One object medianly on table... | 57        | 41       | 2        | 140       |
| Two objects at once.....        | 80        | 20       | -        | 20        |
| One obj. presented in E's hand  | 53        | 47       | -        | 130       |
| Objects picked up.....          | 66        | 34       | -        | 207       |

From Table IV it will be seen that when the entire test series is taken as a whole, the right hand was used definitely more than the left, particularly when one object was placed centrally in front of the child, and when objects were picked up during the play period. The percentages in favor of the right hand when two objects were presented at once, while large, really are not significant, since the number of trials is so small.

From Fig. 7 it will be seen that the dominance of the hands of Subject 4 alternated quite regularly. No attempt to divide this test series into periods of lateral dominance was undertaken, however, because of the small number of the tests.

The situation here presented may be the result of the lack of control in the experimental set-up rather than of an actual right-hand preference on the part of the child. The object, when placed before the child, may inadvertently have been placed somewhat toward the right oftener than toward the left side. On the other hand, a right-dominance may actually be present and the fluctuations indicated in the diagram may really have occurred. In this case, the evidence for the suggestion made earlier, namely, of a possible inverse relationship between degree of lateral dominance and extent of fluctuation of dominance, would be strengthened.

It is interesting to note the almost total lack of use of both hands together to secure one object in the case of this subject. Two possible explanations of this situation offer themselves: on the one hand, the possibility that objects were not really centrally presented might account for it; on the other hand, a more evenly developed skill of the two hands, resulting from the frequent fluctuations in dominance, might be the causal factor.

The family history in this case gives left-handedness on the part of the mother's brother.

Subject 4, comparative activity of the hands in spontaneous manipulation of objects.—Results of the timing of spontaneous manipulative activity of the two hands of this subject are shown in Fig. 8, and indicate fluctuations similar to those found in the use of the hands in reaching for objects. Comparison of Figs. 7 and 8 shows the relationship between the two types of activity.



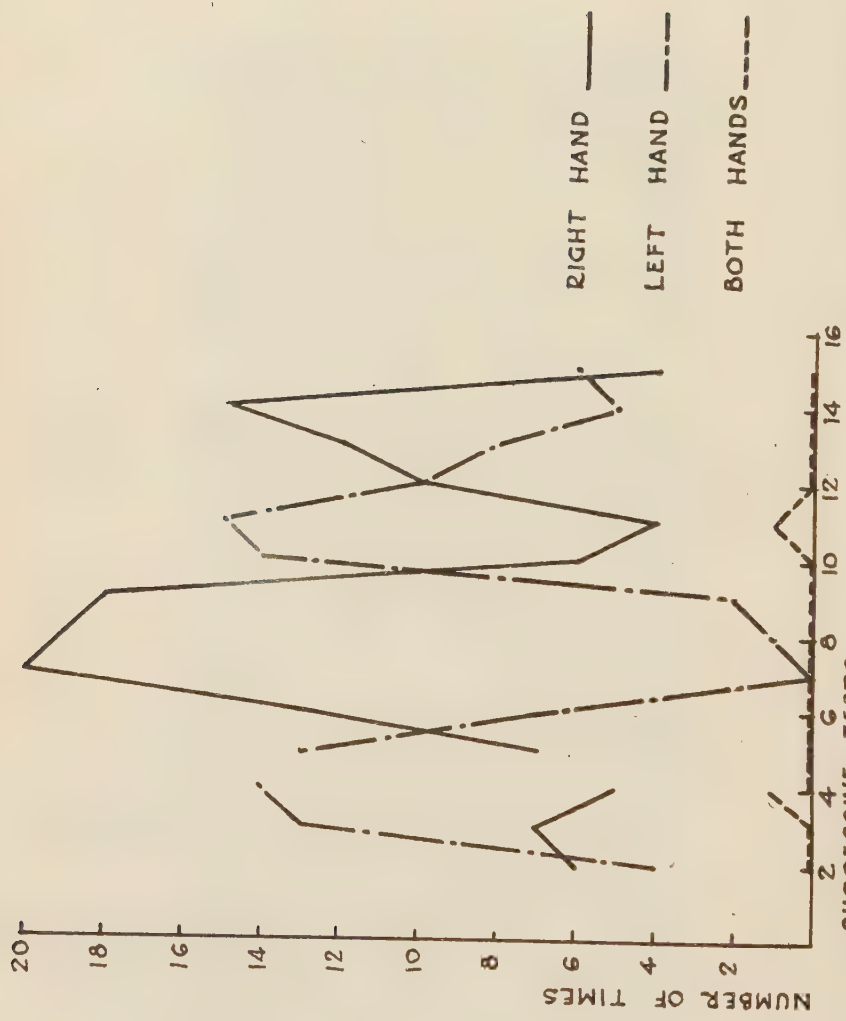


Fig. 7 - Subject 4, total number times hands used in reaching for objects in controlled experiments. Interval indicates considerable time elapsed between tests.

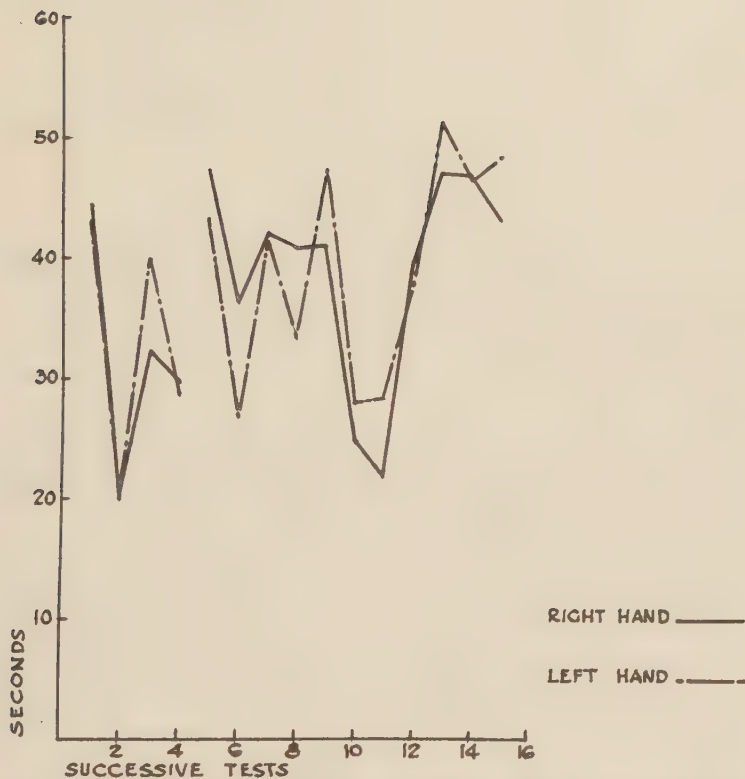


Fig. 8 - Subject 4, average amount per minute spontaneous activity of hands in manipulating objects during free play. Interval indicates considerable time elapsed between tests.

It was particularly in connection with observations of this subject that it became apparent that timing of movement would serve as a more adequate criterion of the spontaneous activity of the two hands than timing of manipulation of objects. The change was not made, however, and the difference between the two hands, particularly during the last three or four observations, favored the left hand somewhat more than should have been the case. At this time the child was in her play pen most of the time, and often held to the side of the pen with one hand while using the other hand to manipulate objects or otherwise keeping the other hand in action. The supporting hand was not so often the left hand as was the case with Subjects 1 and 3, but the impression of the experimenter was that the left hand held this supporting position more often than did the right.

In general, then, the results for Subject 4, as far as they may be considered reliable, indicate a much smaller degree of differentiation between the two hands than is the case for the other three subjects observed. Such dominance as there is, belongs to the right side.

#### Conclusions

1. There is a significant difference in the amount of spontaneous activity of the two hands, and this difference bears a positive relationship to the preferential use of the hands in reaching for objects. Timing of spontaneous activity is, therefore, a valid method of securing evidence concerning hand dominance.

2. There are individual differences in degree of hand dominance.

3. There is evidence of shift or transfer in hand dominance, and there is some evidence of a definite periodicity in this transference. There is, further, a possibility of an inverse relationship between degree of hand dominance and extent of fluctuation in dominance.

4. Some possibility of an hereditary factor is suggested in the family histories. Of the two definitely right-dominant subjects (Subjects 1 and 3) the histories include no known cases of left-dominance in the families; the history of the much less right-dominant subject (Subject 4) gives one case of left-dominance in the family; while the history of the definitely left-dominant subject (Subject 2) gives two cases of ambidexterity and one case of left-dominance in the family.

### CHAPTER III

#### CASE STUDIES OF INFANTS DURING THE FIRST SEVEN MONTHS OF LIFE

The results of the preliminary investigations indicated the presence of a positive relationship between the spontaneous activity of the hands and their preferential use in reaching for objects, and also served to establish a technique for securing records of manual activity.

The main investigation was then undertaken, in order to study the manual activity of younger infants to determine at what period differentiation between the two hands sets in.

#### Subject Group

It was thought that two to four weeks of age would be a sufficiently early starting point. Accordingly, a group of seven infants was secured, of ages ranging from ten days to thirty days, to serve as subjects in this section of the investigation.

Dr. Adair, director of Chicago Lying-in Hospital, sanctioned the investigation, and Dr. Hunt, house physician of the same institution, gave willing cooperation in the matter of selecting the babies and securing the consent of the mothers.

No particular standards were set up, except that the infants were to have been pronounced normal at birth, and the mothers were to be willing to cooperate intelligently. Beyond this, the selection was a random one based largely upon the location of the homes, reasonable accessibility from the University of Chicago neighbor being the determining factor.

Subject 5 -- Boy baby Bruce, born January 11th, was observed from February 14th to July 29th, that is, from five weeks to six and one-half months of age.

Subject 6 -- Girl baby Joan, born January 14th, was observed from January 24th to August 18th, that is, from ten days to seven months of age.

Subject 7 -- Boy baby Charles, born January 17th, was observed from February 13th to August 3rd, that is, from four weeks to six and one-half months of age.

Subject 8 -- Boy baby Dan, born January 15th, was observed from February 21st to August 22nd, that is, from five weeks to seven months of age. Additional observations were carried on by Dan's mother during the month of September, his eighth month of life.

Subject 9 -- Boy baby Oscar, born January 11th, was observed from January 24th to June 5th, that is, from thirteen days to approximately five months of age.

Subject 10 -- Girl baby Christine, born March 29th, was observed from April 10th to July 21st, that is from twelve days to almost four months of age.

Subject 11 -- Boy baby William, born April 3rd, was observed from April 18th to July 22nd, that is, from fifteen days to almost four months of age.

## Method of Procedure

Schedule of observation.— Observations of all subjects took place in the homes, and were arranged to fit into the babies' schedules without interfering in any way with the regular routine. The time of day of the observations was varied systematically in order to secure the most representative sampling of the baby's activity.

Observations of Subjects 5, 6, 7, 8, and 9 were arranged to take place four days per week for two weeks, alternating with two weeks of non-observance. This routine was continued for two months, after which it was changed to two observations per week without intermission. Subjects 10 and 11 were observed according to the latter schedule throughout the test series.

Occasional interruptions of the schedule occurred, of course, but as far as possible the routines were maintained (except in the case of Subject 9, whose records were intermittent and were suspended sooner than had been intended) until about July 1st, that is, approximately five and one-half months. Subjects 10 and 11 were not started until the middle of April and were thus followed for approximately two and one-half months in this test series. On July 1st the observations of all these subjects were suspended for a period of three weeks, at the end of which interval they were resumed for varying lengths of time for the several subjects.

Details of procedure.— All observations occurring before the subjects were six months of age were confined to timing of spontaneous activity of the hands plus descriptions of the position of the child, direction of the light, type of activity, and any unusual circumstances that might have been noticed. After Subjects 5, 6, 7 and 8 reached the age of six months, tests to secure records of the use of the hands in reaching were instituted. Moving pictures, also, were taken, not only of several members of this subject group but also of two subjects of the preliminary investigation and one of the supplementary investigation to be described later.

At each test period, records of the spontaneous activity of the infant's hands were taken according to the technique described in Chapter II, with the modification that the three six-minute timing periods were separated by intervals definitely one and one-half minutes in length. During these intervals notes were taken concerning the position of the baby, and so on.

The infants were observed in whatever situation they happened to be at the time the experimenter arrived, the object being to secure samplings of activity which occurs in the normal course of the child's behavior. The situation was always noted in order to determine whether or not restriction of arms, direction of light, etc., influenced the amount of activity. The experimenter wished to secure records, not of what would happen if the infant were placed in some particular situation, but of what actually does happen in the infant's normal environment.

The technique described above was followed throughout the observations and only on rare occasions were there any variations from this procedure. In a very few instances the last six-minute period was reduced to four minutes, rather than six minutes, in length. The records are remarkably uniform, considering the length of the test series.

"Activity" included all movement of any part of the hand, i.e., finger movement, movement of the hand through wrist flexion, and movement of the hand through arm action. Non-movement, then, meant complete lack of movement of all parts of the hand. It did not necessarily imply relaxation of the hand. The hand might be held in the air, but as long as no movement could be discerned, the interval was considered not active. The slightest movements, however, were watched for and included. These small movements were particularly important during the early period, as much of the inde-



pendent activity of the two hands at that stage consisted in finger and wrist movement.

Finger and thumb sucking constituted a problem in judgment of activity, and was solved as follows. When a finger or thumb was held in the mouth but no signs of activity could be discerned, the hand was considered not active. Whenever the finger or thumb was sucked with sufficient vigor, however, to cause movement of the hand, the hand was considered active. It might be argued that in such case the activity was really of the mouth rather than of the hand, but since this situation was usually accompanied by movement of the other hand, it seemed reasonable to assume that some finger movement was taking place in the mouth.

The routine described above, namely, three six-minute periods of timing of hand movement separated by intervals of one and one-half minutes, was continued until the infants reached six months of age. After the end of the sixth month, tests of the use of the hands in reaching were added to the routine. As nearly as possible the following schedule was then carried out:

1. Six-minute timing of hand movement.
2. Presentation of an object ten times.
3. Second six-minute timing of hand movement.
4. Presentation of an object ten times.
5. Third six-minute timing of hand movement.

With these younger infants, the presentation of objects could not be carried out in a wholly controlled situation, nor could the number of presentations be maintained exactly. Every effort was made, however, to control the situation as far as possible. In most instances the infant was lying on his back on his bed, but in a few cases, particularly in the later tests, he might have been propped up in a sitting position. Whichever the position, it was always ascertained that the two hands were equally free to reach for the object presented, and the object was always presented in the median plane above or in front of the child.

It was found that the best method of presentation of an object (a colored block, a colored bracelet, or occasionally the experimenter's stop watch) was to have it hanging before the child. A block tied on the end of a string seemed to catch the infant's attention much more successfully than a block held in the experimenter's hand. At this early age it was impossible to present an object on a flat surface in front of the child, even when the infant was propped in a sitting position. His eye-hand coordinations seem not yet equal to the complexity of such a situation. By the time he is able to sit up without support such coordination is manifested, but not until then. Attempts to test the six and one-half months old infant in a high chair, therefore, were not successful.

In order to control the situation as far as possible, the object was hung in the median plane in front of the child on a cord long enough so that the experimenter's hand did not constitute part of the stimulus. To make sure of this, however, the hand holding the cord was alternated right and left each successive trial.

Some complications entered when the child, in attempting to grasp the object, started it swinging, thus moving it out of the median plane. In most instances the hand that reached for the object and induced the swinging also followed the object until it was grasped, but occasionally the other hand entered into the activity when the first grasping attempt was not successful. The experimenter made every effort to secure trials in which the successful grasp was completed as nearly as possible in the median plane. No trial was counted unless the object was successfully grasped and held in the hand for a recognizable interval. The cord supporting the

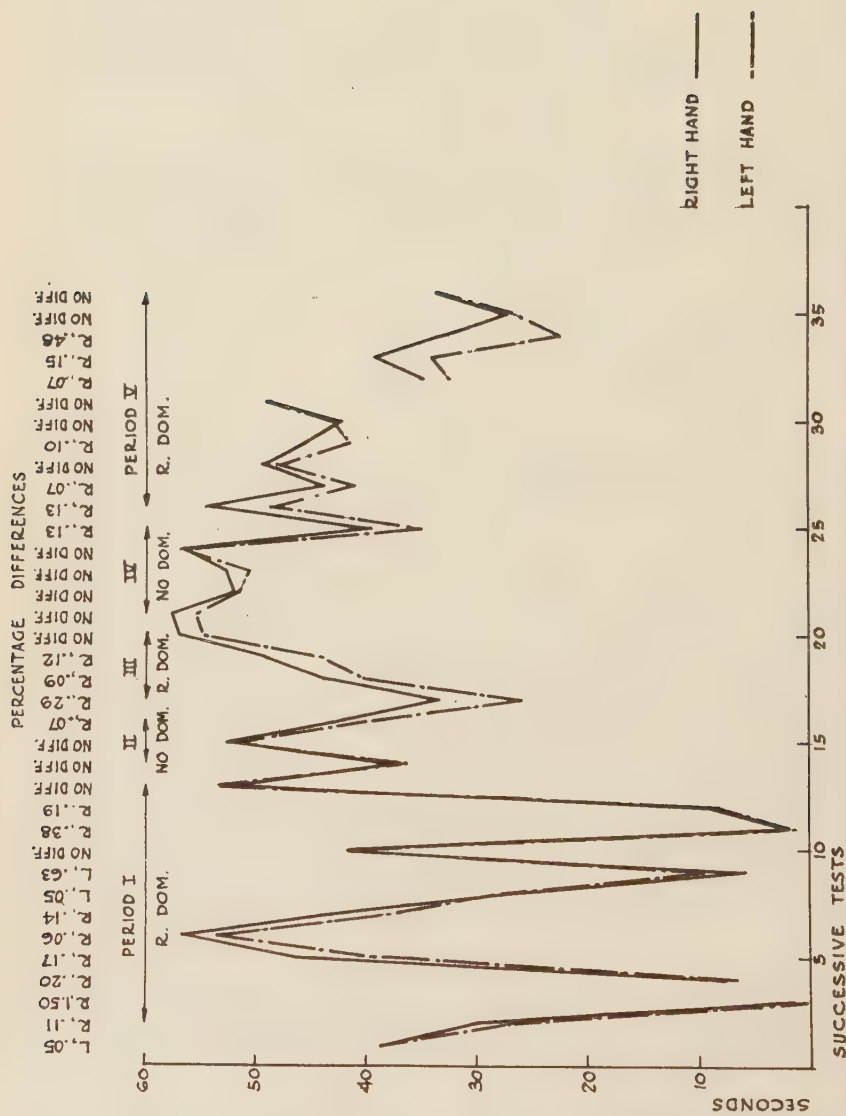


Fig. 9 - Subject 5, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Intervals indicate considerable time elapsed between tests.

object was released as soon as the object seemed to be firmly grasped, so that the infant's hold could be determined.

While it was the experimenter's aim to secure twenty trials per test period, this was not always possible. Sometimes fewer and sometimes more trials were completed, depending upon the extent of the child's interest in the situation. The tests were continued sufficiently long to secure enough trials in each case to determine with some reliability the comparative use of the hands at this stage of development. The total number of trials per individual varied from one hundred and ten to one hundred and seventy-five for the four subjects.

## Results

Comparative activity of the hands in spontaneous movement.- Figures 9, 10, 11, 12, 13, 14 and 15 give the average daily records of the spontaneous activity of the hands of Subjects 5, 6, 7, 8, 9, 10 and 11 in terms of seconds, while Figs. 16, 17, 18, 19, 20, 21 and 22 present the same data in cumulative form.

Inspection of these figures reveals differentiation between the two hands for all seven subjects. Subjects 5, 6, 8, and 11 (see Figs. 16, 17, 19 and 22, respectively) show differentiation favoring the right hand, while Subjects 7, 9 and 10 (see Figs. 18, 20 and 21, respectively) show differentiation favoring the left hand.

Cursory inspection of Figs. 18, 20, and 21 reveals a right-dominant period, coming at the beginning or soon after, on the part of the three left-dominant subjects, which makes the records of these subjects appear to favor the left hand less definitely than the records of the four right-dominant subjects favor the right hand. When the figures are more carefully analysed, however, similar though less extreme fluctuations in the records of the right-dominant subjects are also seen.

Turning to Figs. 9, 10, 11, 12, 13, 14 and 15, it will be noted that periods of alternating hand dominance, labeled Periods I, II and so on, are indicated in each case. The "Periods" or phases in the records of this experimental group, in contrast to the determination of the "Periods" in the records of the preliminary experimental group described in Chapter II, were determined by a more precise method. Percentage differences in amount of activity of the two hands were computed for each test day. Those test days on which the percentage differences were less than five per cent were then arbitrarily labeled "no difference," while those days on which one hand shows as much as five per cent greater average amount of activity per minute than the other hand, are labeled right or left-dominant, as the case might be.

Again arbitrarily, three successive rights, lefts or no-differences were settled upon as constituting a "Period." A succession of rights, for example, might be interrupted by one or more lefts or no-differences but continues to be termed a right-dominant period until as many as three lefts or no-differences occur in succession. Likewise, a series of lefts, until interrupted by three successive rights or three no-differences, is termed a left-dominant period.

The no-dominant periods are arrived at by two methods. A succession of as many as three or more tests showing no difference between the two hands (according to the arbitrarily fixed standard) is termed a no-dominant period, while a succession of right, lefts and no-differences so intermingled that neither of the three occurs three times in succession, is likewise so termed. It will be seen that these periods are also designated on Figs. 16-22, while Fig 23 shows this periodicity of hand dominance for the several subjects in terms of weeks.

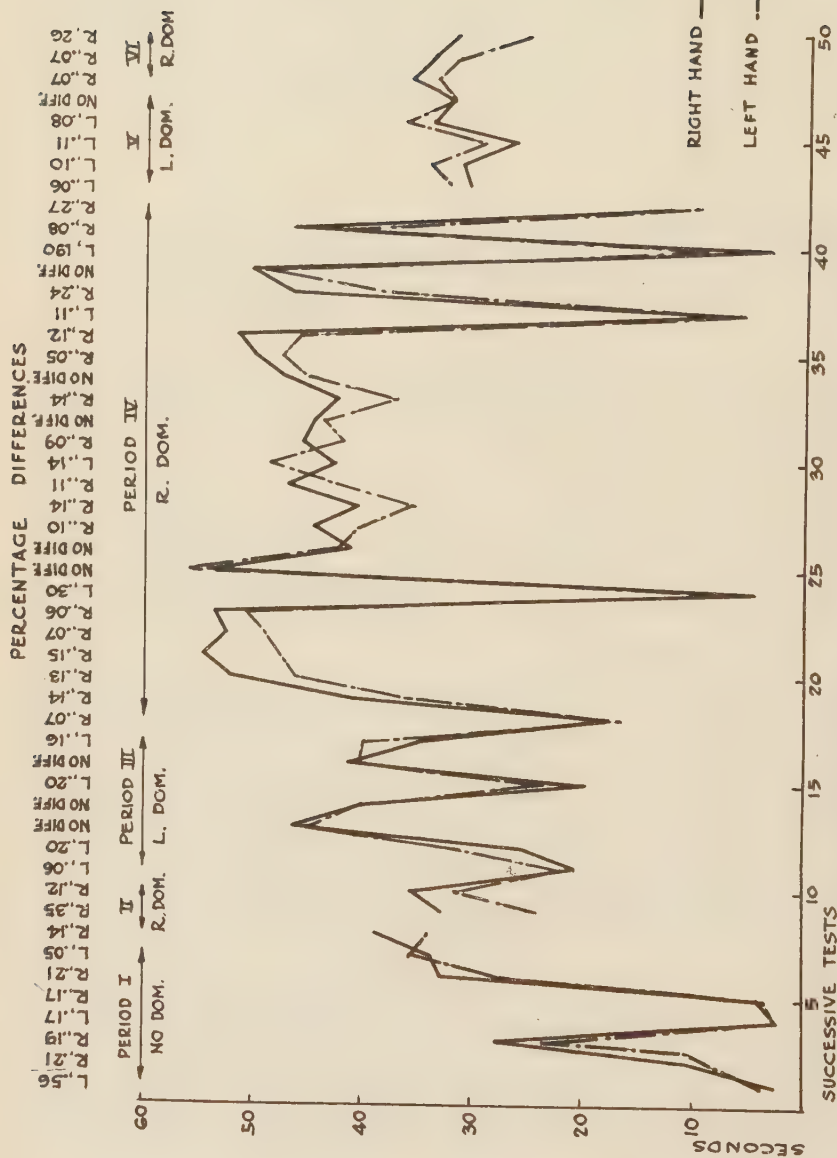


Fig. 10 - Subject 6, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Intervals indicate considerable time elapsed between tests.





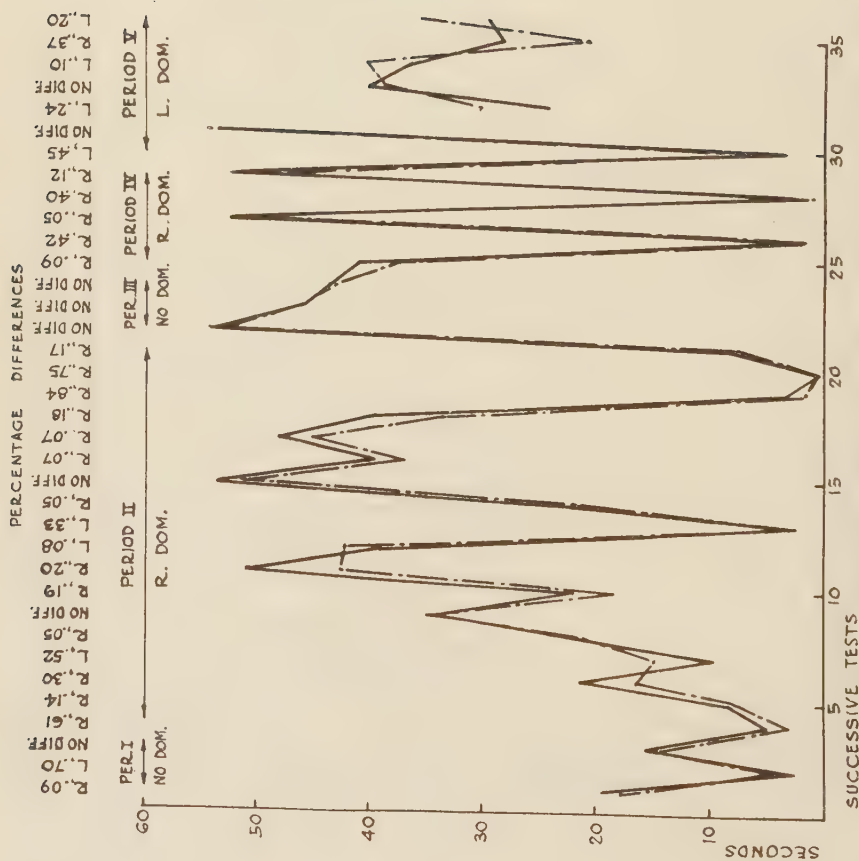


Fig. 12 - Subject 8, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Interval indicates considerable time elapsed between tests.

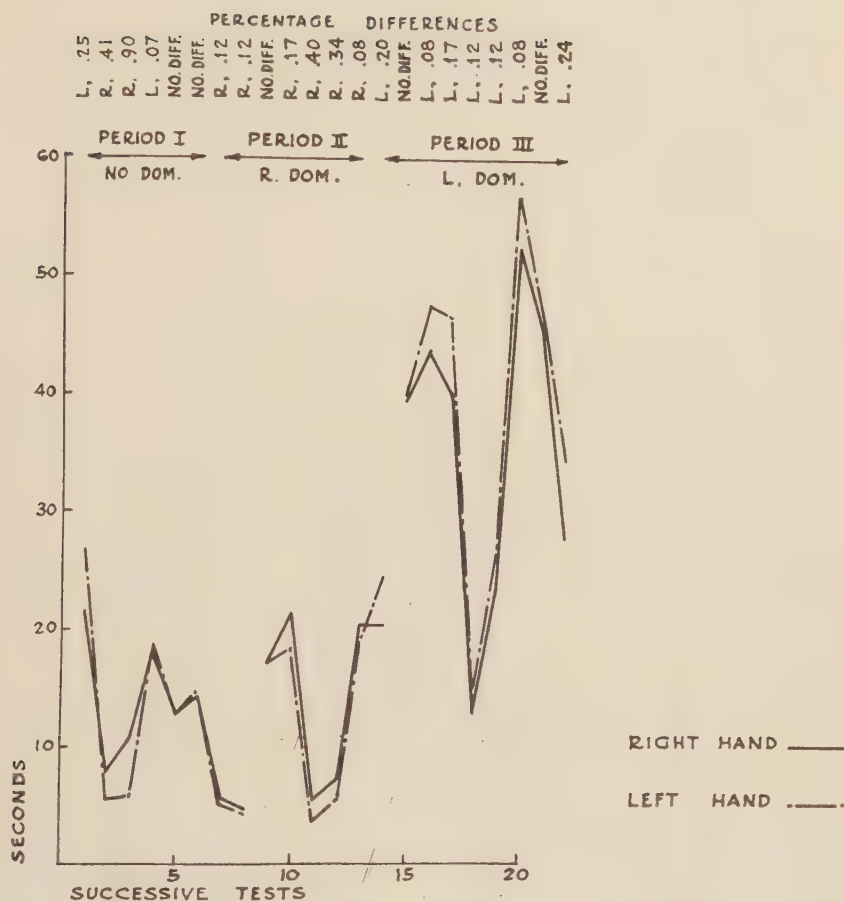


Fig. 13 - Subject 9, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Intervals indicate considerable time elapsed between tests.

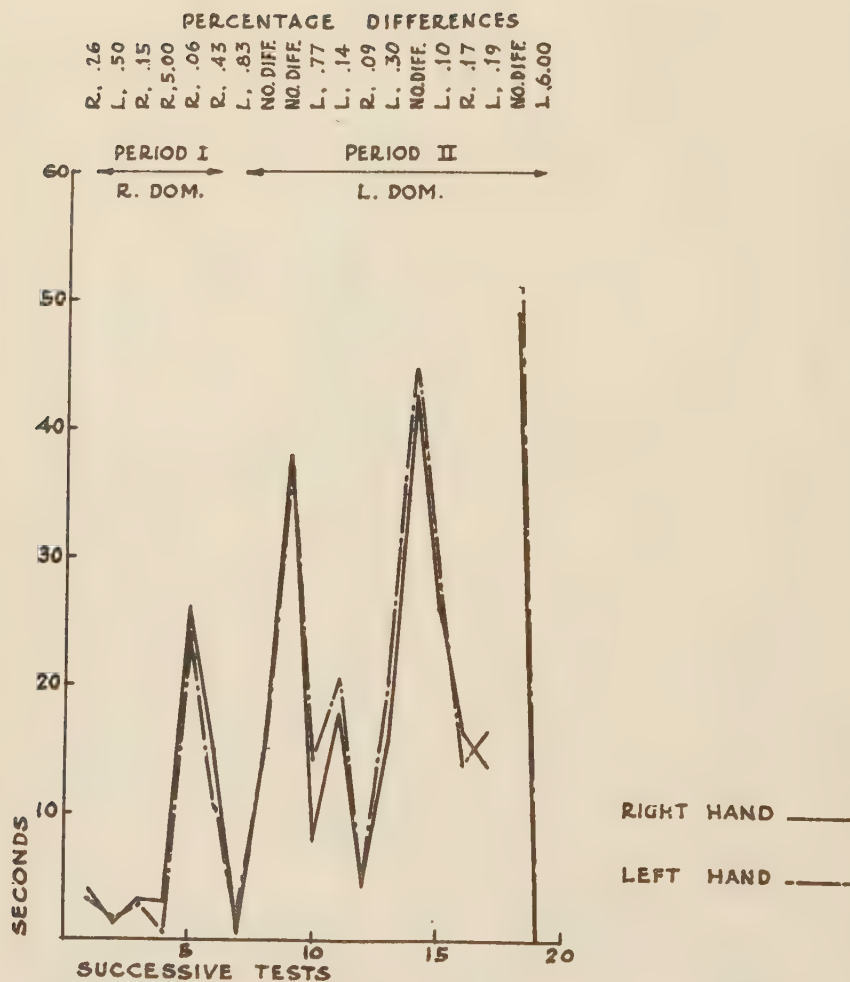


Fig 14 - Subject 10, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Interval indicates considerable time elapsed between tests.

## PERCENTAGE DIFFERENCES

|         |          |        |        |        |        |          |        |        |        |          |        |        |
|---------|----------|--------|--------|--------|--------|----------|--------|--------|--------|----------|--------|--------|
| R. .08  | NO.DIFF. | L. .45 | L. .32 | R. .06 | L. .22 | NO.DIFF. | R. .23 | R. .11 | R. .10 | NO.DIFF. | R. .23 | R. .16 |
| R. .13  | NO.DIFF. | L. .45 | L. .32 | R. .06 | L. .22 | NO.DIFF. | R. .23 | R. .11 | R. .10 | NO.DIFF. | R. .23 | R. .16 |
| R. .207 | NO.DIFF. | L. .45 | L. .32 | R. .06 | L. .22 | NO.DIFF. | R. .23 | R. .11 | R. .10 | NO.DIFF. | R. .23 | R. .16 |

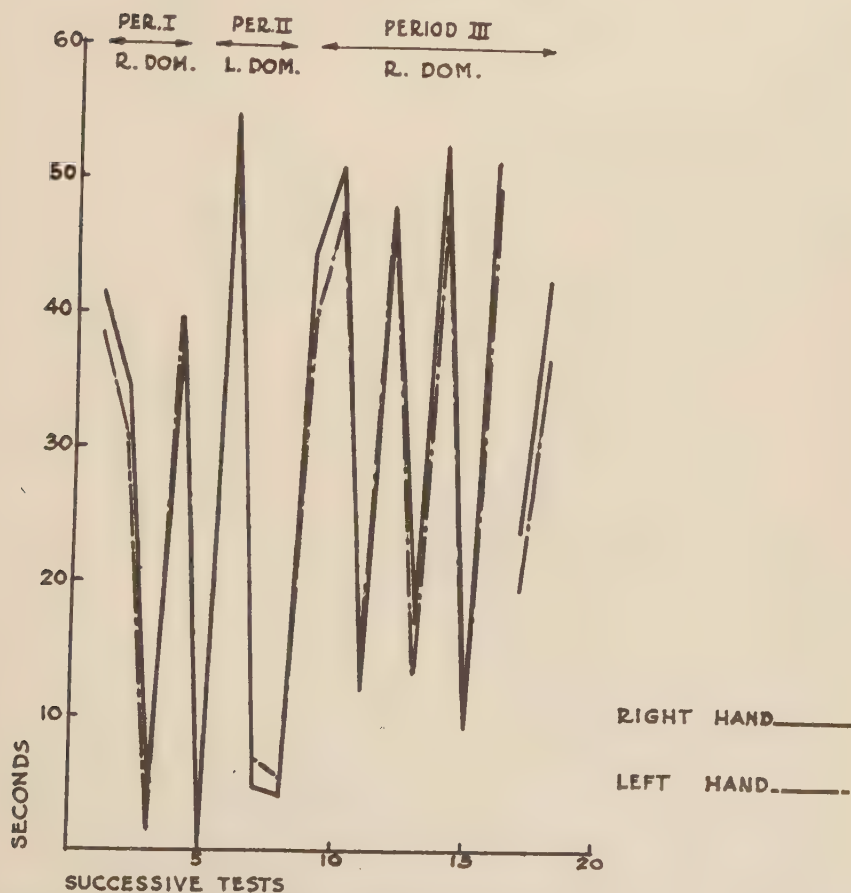


Fig. 15 - Subject 11, average amount per minute spontaneous activity of hands. Periods refer to phases in hand dominance, determined by percentage differences favoring R or L as shown. Less than 5% arbitrarily called no difference. Interval indicates considerable time elapsed between tests.

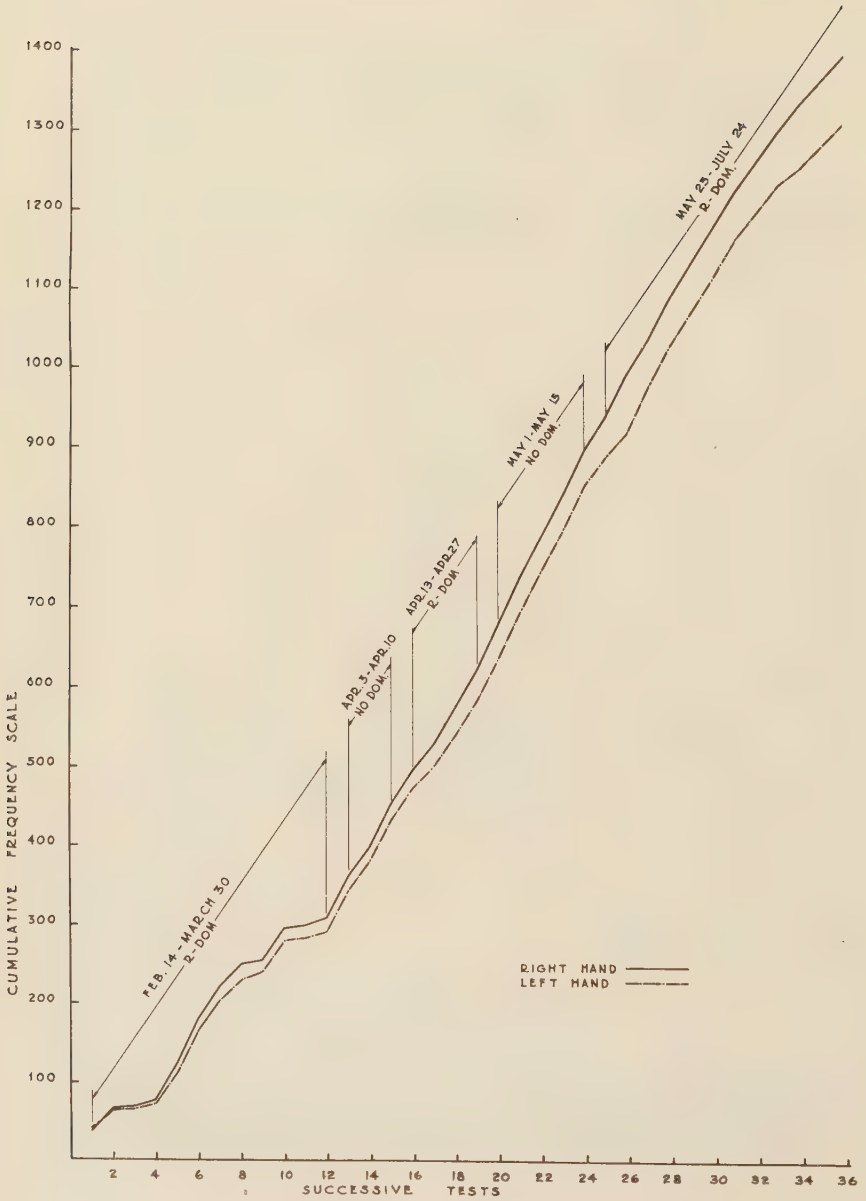


Fig. 16 - Cumulative frequency curve for activity of hands. Subject 5.



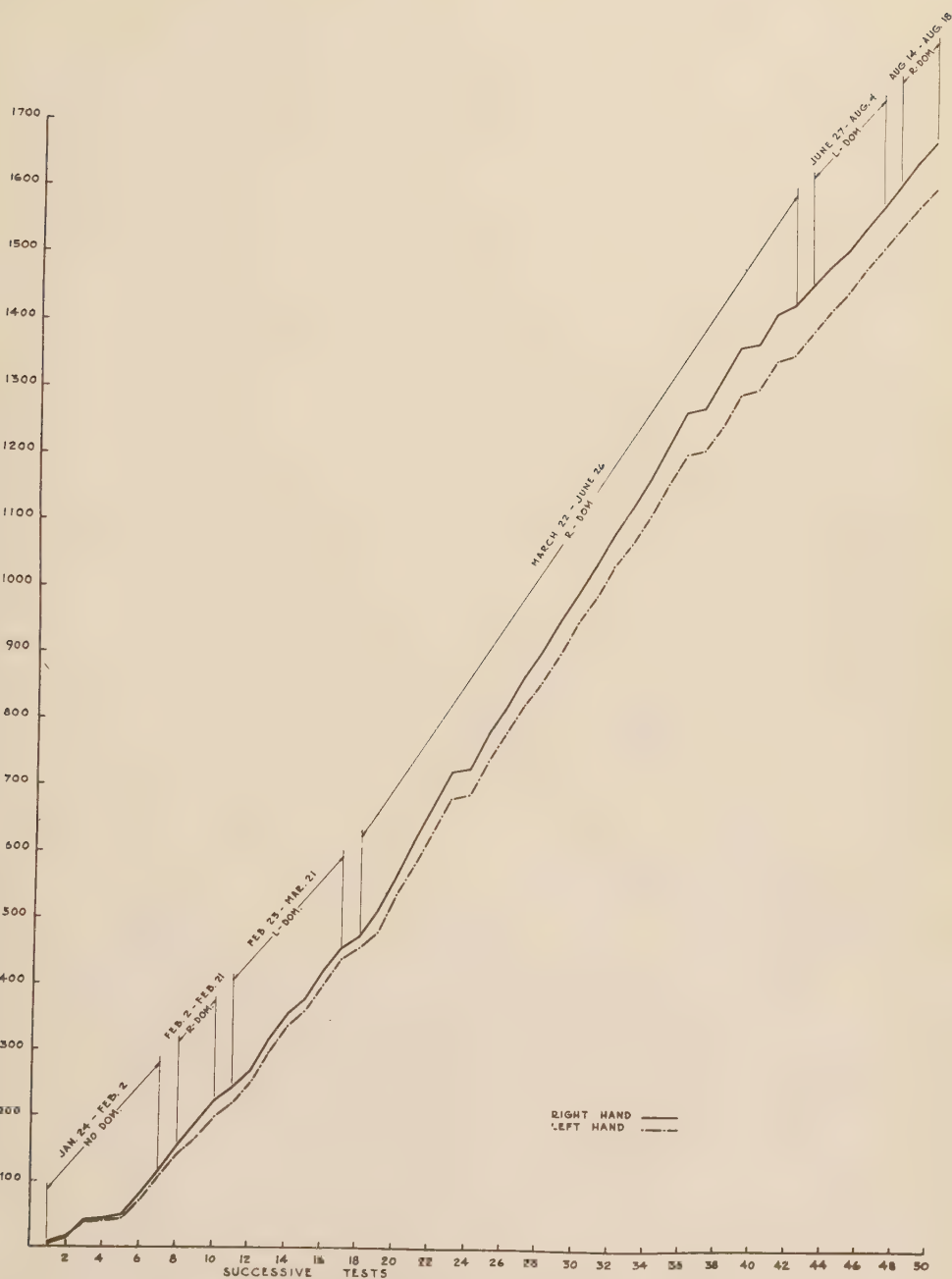


Fig. 17 - Cumulative frequency curve for activity of hands, Subject 6.

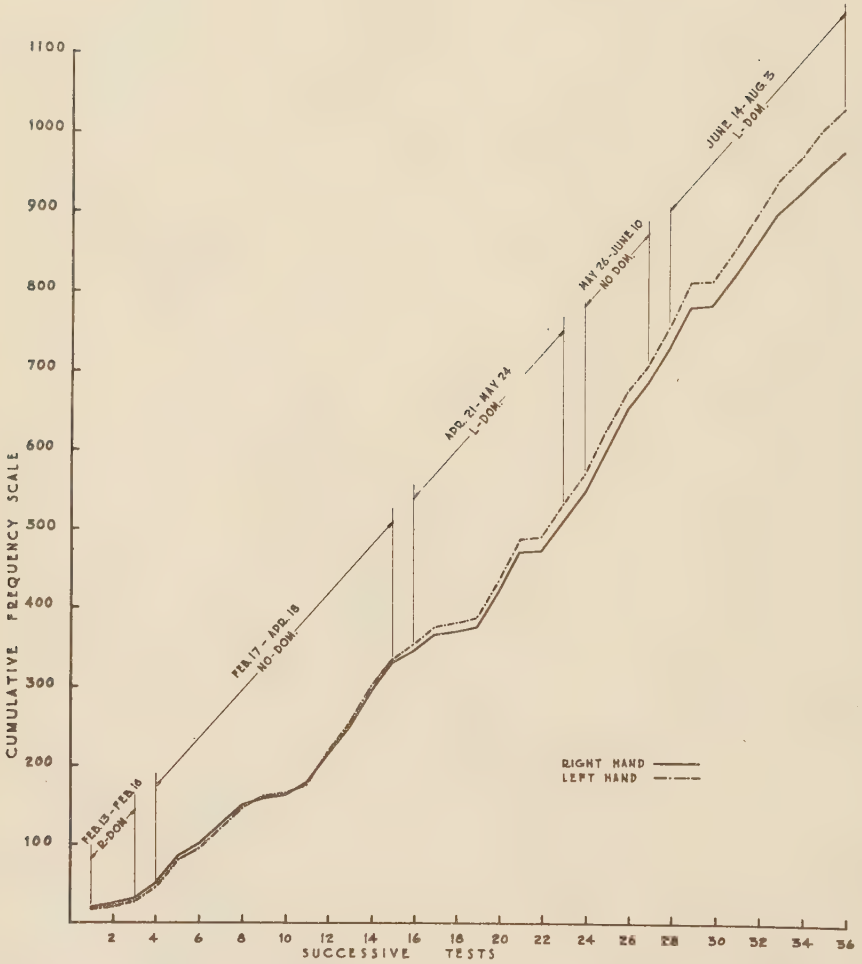


Fig. 18 - Cumulative frequency curve for activity of hands. Subject 7.

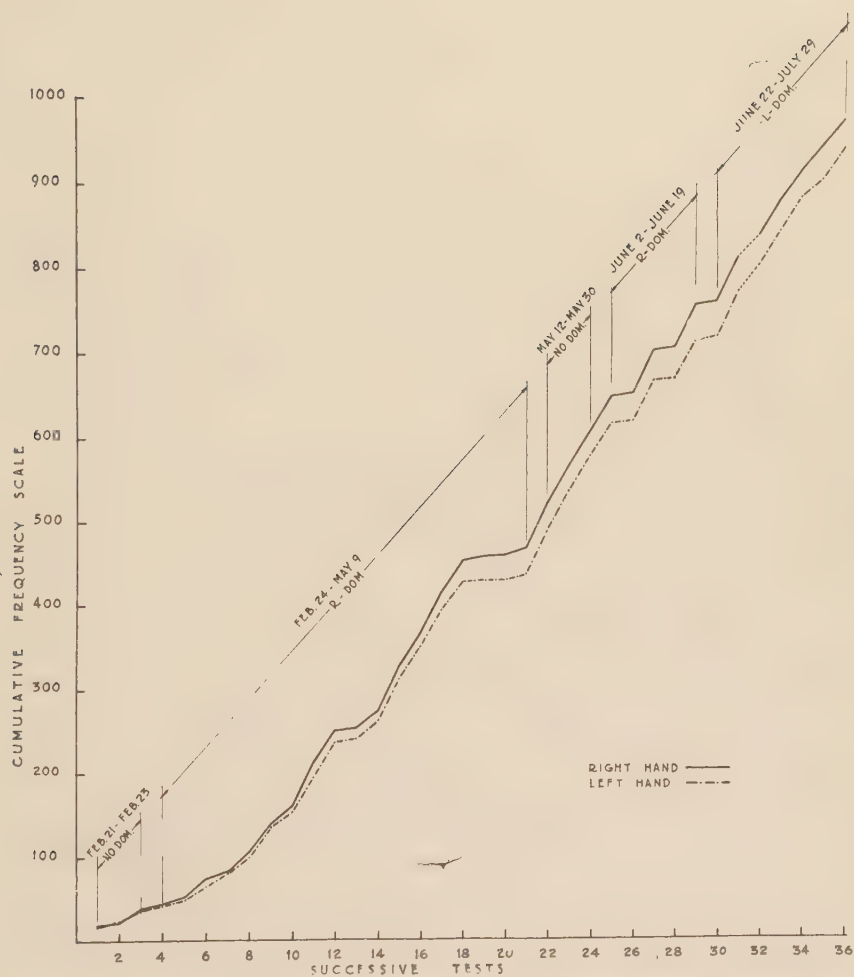


Fig. 19 - Cumulative frequency curve for activity of hands. Subject 8.

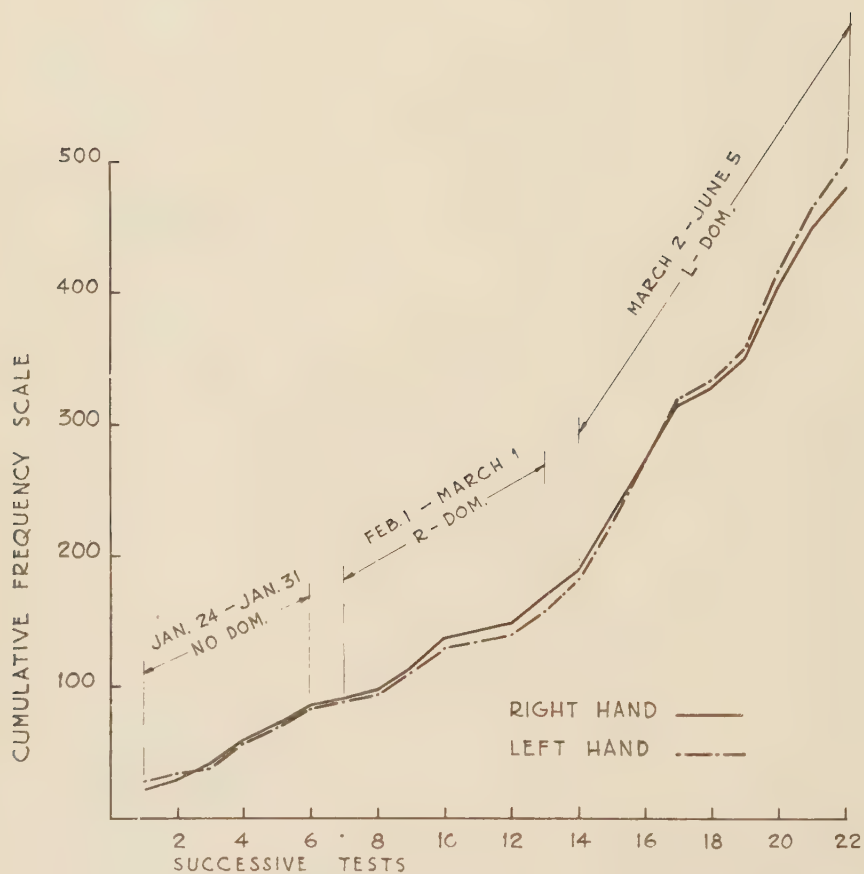


Fig. 20 - Cumulative frequency curve for activity of hands. Subject 9.

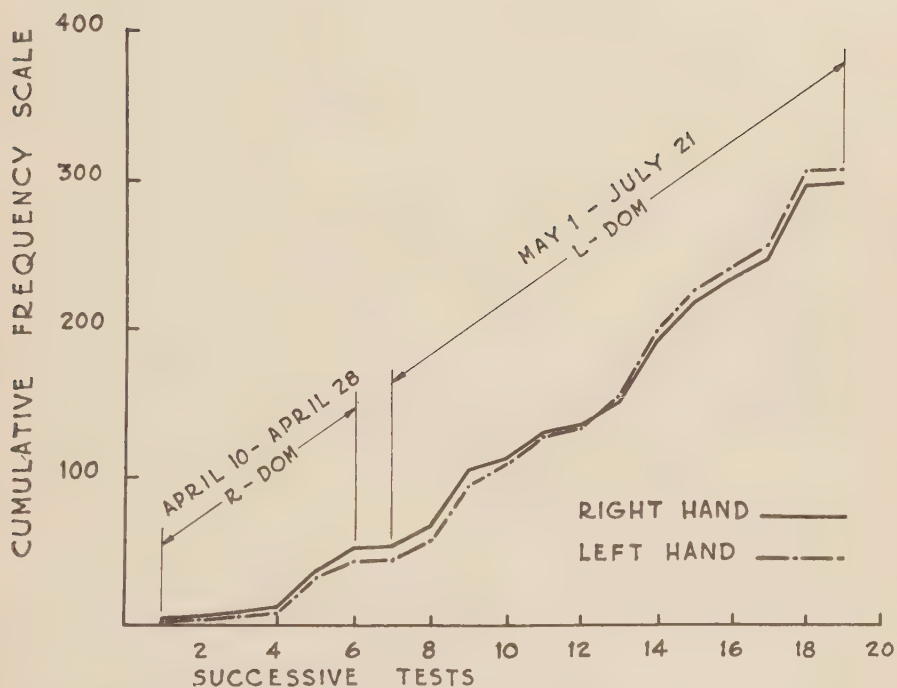


Fig. 21 - Cumulative frequency curve for activity of hands. Subject 10.



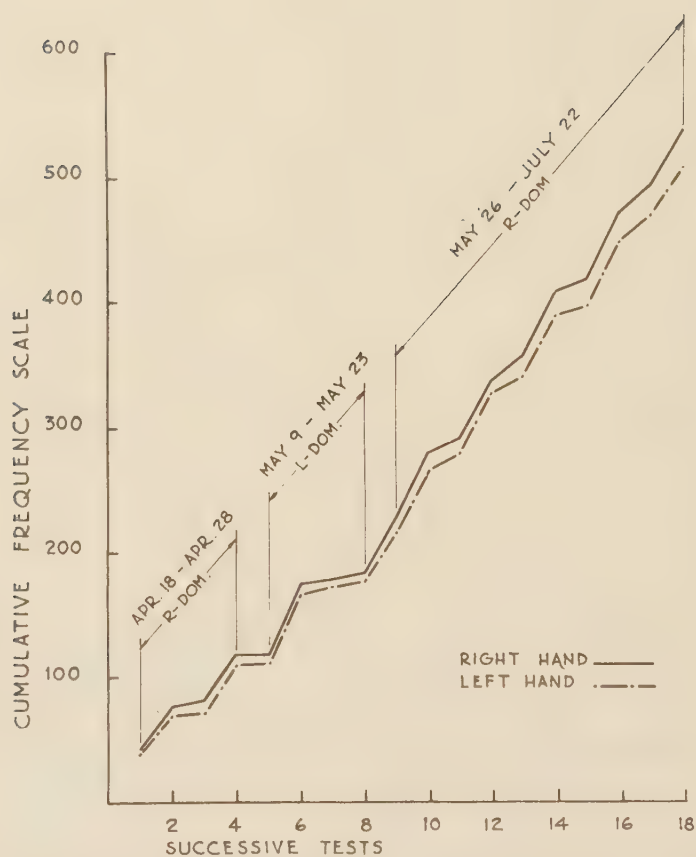


Fig. 22 - Cumulative frequency curve for activity of hands. Subject 11.

Before discussing these periods further, it should be noted that the technique used in this investigation is less satisfactory in the early weeks when the infant's movements are somewhat intermittent, than in later periods when the child is more consistently in action. By about the third month the babies were awake and consistently active during observation periods so that timing of each hand alternately gave representative sampling of the activity of the two hands, but earlier than that this method of alternate observation of the two hands is not reliable. If both hands could have been timed at once, or if longer and more frequent observation periods could have taken place, the results would have been more satisfactory. The latter method was used in the supplementary study of new-born infants and proved better for this early age level.

Returning to Fig. 23, considerable variation between subjects is shown, but certain interesting similarities are also to be noted. A definite trend toward either right or left-dominance seems to have set in for all except Subject 7 by the eleventh week. An early period of left-dominance for two of the right-dominant subjects (Subjects 6 and 11), and likewise an early period of right-dominance for all three of the left-dominant subjects (Subjects 7, 9 and 10) is seen.

Why Subject 7 should have delayed so long in establishing his left hand dominance, is impossible to say. The results as recorded, namely a long period of no-dominance, seemed true to the actual situation, and yet after left-dominance began showing itself the child seemed very left-dominant and remained so to the end of the test series.

Similarly, Subject 9 seemed very decidedly left-dominant, after left-dominance set in, although an early period of right-dominance had preceded the development of left-dominance. From the eighth week on, the difference between the amount of activity of his two hands was so obvious that the timing records would have been superfluous to anyone watching the child's hand movement. Unfortunately, his timing records were only intermittent, and moving picture records could not be secured.

Subject 5, on the other hand, seems to have shown a definite right-dominance from the start of the test series, and maintained this dominance, except for two periods of no-dominance. If the experimenter's impression is of any value, it may be said that this subject seemed most right-dominant of the four right-dominant subjects, and this view is borne out by his records for reaching for objects, later in the test series, and also by the moving picture records. See Plates IV and V.

While Subjects 5 and 7, then remained right and left-dominant, respectively, to the end of the test series, Subjects 6 and 8, the other two subjects whose records were carried beyond the six months age level, each show a shift in dominance at this later age period. See Figs. 10, 12 and 23.

Concerning evidence of periodicity in hand dominance, it may be said, then, that while the same types of fluctuations take place in the several cases, they vary both in length and in degree. Subjects 6 and 11 of the right-dominant group show transference to definite left-dominance at the six to twelve weeks age level, while Subject 8 shows only a short no-dominant period and Subject 5 shows no shift at this time, although this subject, too, might have shown something of the kind, had records been taken in the sixth and seventh weeks (see Fig. 23). Of the left-dominant subjects, all three show a period of right-dominance at this age level.

At the six and seven months level, right-dominant Subjects 6 and 8 show an extreme transference to left-dominance, while neither right-dominant

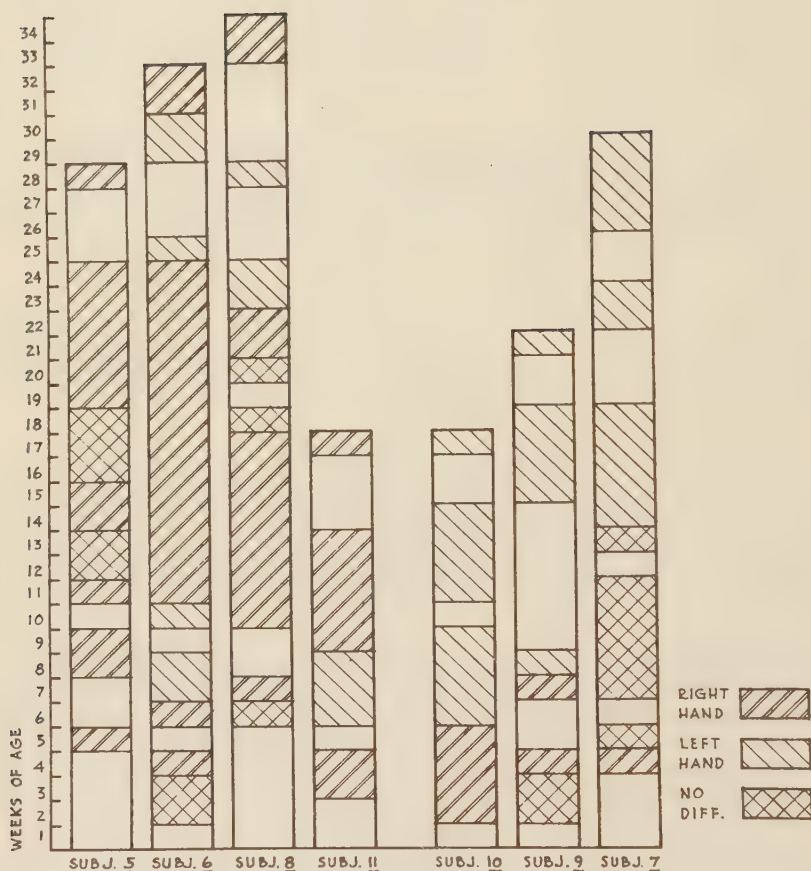


Fig. 23 - Periodicity of hand dominance, subjects 5 - 11, in terms of weeks of age. Blank portions of columns indicate no tests given.

TABLE V

EXTENT OF LATERAL DOMINANCE, SUBJECTS 5 - 11, SHOWING TIME,  
IN TERMS OF WEEKS, DURING WHICH RIGHT, LEFT AND NEITHER  
HAND WAS MORE ACTIVE THAN THE OTHER

| Dominant Hand | Sub-ject      | More Active Hand |    |          |    |          |     | Total No. Weeks Tested | Age Range of Total Test Series |
|---------------|---------------|------------------|----|----------|----|----------|-----|------------------------|--------------------------------|
|               |               | Right            |    | Left     |    | Neither  |     |                        |                                |
|               |               | No. Wks.         | %  | No. Wks. | %  | No. Wks. | %   |                        |                                |
| Right         | <u>11</u> ... | 8                | 73 | 3        | 27 | -        | -   | 11                     | 16das.-3½mos.                  |
|               | <u>5</u> ...  | 13               | 72 | -        | -  | 5        | 28  | 18                     | 33das.-6½mos.                  |
|               | <u>6</u> ...  | 18               | 69 | 6        | 23 | 2        | 8   | 26                     | 14das.-7½mos.                  |
|               | <u>8</u> ...  | 13               | 68 | 3        | 16 | 3        | 16  | 19                     | 38das.-7½mos.                  |
| Left          | <u>7</u> ...  | 1                | 4- | 11       | 50 | 10       | 45- | 22                     | 28das.-6½mos.                  |
|               | <u>9</u> ...  | 2                | 20 | 6        | 60 | 2        | 20  | 10                     | 14das.-4½mos.                  |
|               | <u>10</u> ... | 4                | 31 | 9        | 69 | -        | -   | 13                     | 13das.-3½mos.                  |

Subject 5, nor left-dominant Subject 7, give evidence of a tranference at that age level. It should be added that shifts may have taken place for these two subjects during the two or three weeks period when no tests were administered, but in this case the fluctuations must have been of very short duration, and therefore, even if present, of much lesser degree than those of the other two subjects.

Individual differences in degree of lateral dominance are thus indicated, and this view is substantiated by the data given in Table V, showing Subject 8 to have been right-dominant during a slightly smaller percentage of the time, with Subject 6 next, Subject 5 next, and Subject 11 most right-dominant. Greater differences appear among the left-dominant subjects, Subject 10 being most left-dominant, with Subject 9 next, and Subject 7 following last.

In summary, therefore, data secured through timing the spontaneous activity of the hands of these infants indicate differentiation between the two hands, with four of the seven subjects showing a dominance of the right and three a dominance of the left hand.

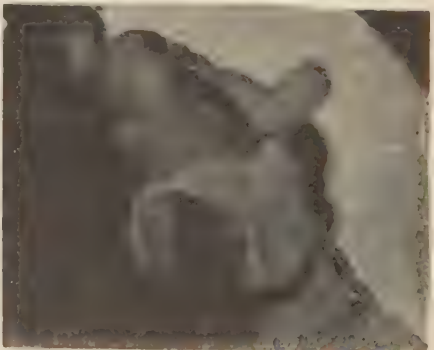
While the early stages of this differentiation may not be accurately revealed by these data, due to the weakness of the technique for the earlier age level, some indication is given of fluctuations in dominance, the right-dominant group showing a shift to left or no-dominance during an interval from about the sixth to the twelfth weeks and the left-dominant group showing a period of right-dominance between the second and the eighth weeks. Whether this time difference is a genuine difference between right and left dominance, or whether it is due to weakness in the technique or to individual differences which happened to result in similarity of the early stages of the four right-dominant subjects and of the three left-dominant subjects cannot be determined.

Another definite fluctuation in dominance occurs in two of the four subjects at the six and seven months age level, and serves to indicate further that the development of hand dominance must be recognized as including fluctuations in dominance along the path of differentiation between the two hands.

Definite individual differences in degree of lateral dominance and in precocity of the development of dominance are shown by these same records

## PLATE III

SUBJECT 11, THREE MONTHS OF AGE, RIGHT DOMINANT, AND SUBJECT 7,  
SIX MONTHS OF AGE, LEFT DOMINANT



Subject 11, sucking right fingers, right leg in motion, left leg quiet.

Subject 7, sucking left fingers, left leg in motion, right leg quiet.



of the number, type and extent of fluctuations.

Finally, a noteworthy aspect of this part of the investigation is the relative incidence of right and left-dominance indicated in this group of subjects. The group is so small, of course, that the proportions of left and right-dominance may be entirely accidental, but three cases of left-dominance in a group of seven subjects is at least surprising.

Use of the hands in reaching for objects.- Results of the tests to determine whether or not there is differentiation between the hands in reaching for objects at the six months age level are shown in terms of percentages in Table VI and in terms of successive daily records in Figs. 24-27.

It will be seen in the table that Subject 5 used his right hand significantly more than left, and that Subject 7 used his left hand significantly more than his right in reaching for objects. This is consistent with the records of these two subjects in the comparative amount of spontaneous activity of the two hands during the time interval in which the reaching records were secured. Compare Figs. 24 and 25 with the last part of Period V in Figs. 9 and 11, respectively.

In the case of Subject 6, it is evident that when this stage of the test series was reached she was in a definitely left-dominant stage. This is shown by the records of her spontaneous manual activity for the interval labeled Period V in Fig. 10. During this period the subject used her left hand significantly more than her right in reaching for objects, also. A shift back to right-dominance in the spontaneous activity of the hands then occurred (Period VI in Fig. 10) and was accompanied by a transference in the use of the hands in reaching, the right hand being used significantly more than the left for reaching in the last part of the test series. See Fig. 26.

On the basis of this subject's successive daily records for the use of the hands in reaching for objects, which show a left-dominant phase followed by a right-dominant one, the reaching results are divided into two periods, labeled Periods I and II, and these periods are found to coincide with Periods V and VI in the records of spontaneous manual activity. The relative use of the two hands in reaching, in these two periods as well as in the test series as a whole, is shown in terms of percentages in Table VI, while the agreement between the spontaneous activity record and the record of the use of the hands in reaching, as far as hand dominance is concerned, is clearly shown by a comparison of Fig. 26 with the later part (Periods V and VI) of Fig. 10.

The definite shifts from right-dominance to left-dominance and then back to right-dominance in the case of Subject 6 are strikingly similar to the shifts in hand dominance shown in the record of Subject 1 (Figs. 1 and 2) in the preliminary investigation. It should also be noted that Subject 6's use of both hands (again see Fig. 26) shows a sudden increase just before the shift from left-dominance back to right-dominance, which is in agreement with the record of Subject 1 in this same connection, and that, as in the case of Subject 1, the results of the tests of the use of the hands in reaching for objects, taken as a whole, show a significant right-dominance. Compare Table I with Subject 6's record in Table VI.

Subject 8, whose spontaneous manual activity record is shown in Fig. 12 and who was diagnosed as a right-dominant case, was also in a period of left-dominance at the six months age level when tests for the use of the hands in reaching for objects were instituted. His spontaneous activity record seems to indicate that a left-dominant stage had set in as early as the fifth month (beginning of Period V, Fig. 12). The tests of this subject for the use of the hands in reaching show left-dominance at this time, in correspondence with the dominance of the left hand in spontaneous activity. See first part of Fig. 27.



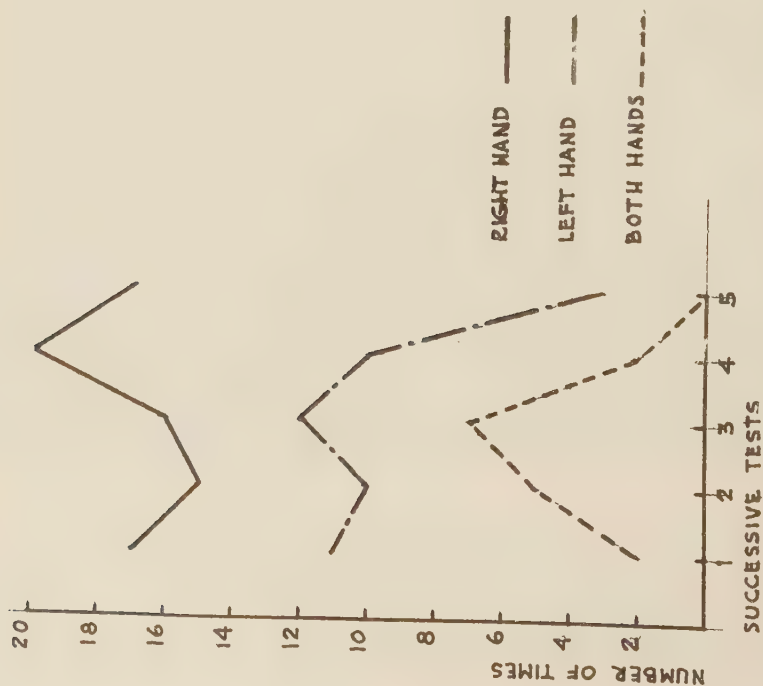


Fig. 24 - Subject 5, total number times hands used in reaching for objects.

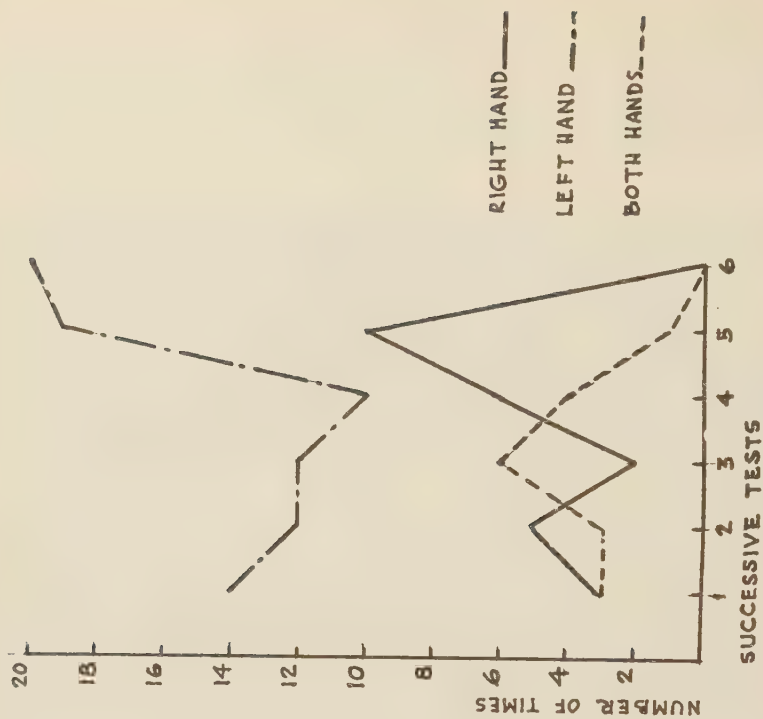


Fig. 25 - Subject 7, total number times hands used in reaching for objects.

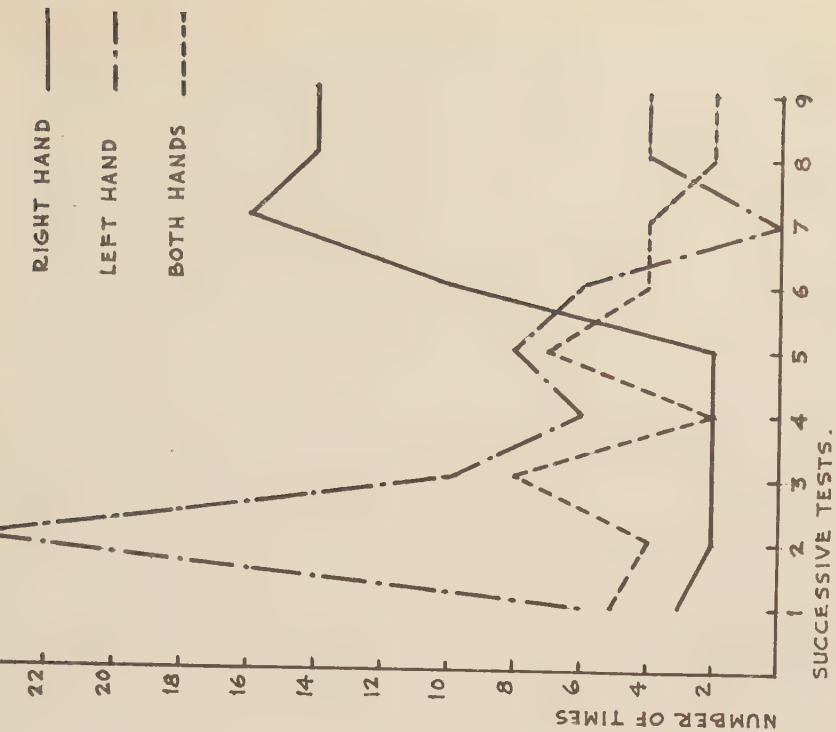


Fig. 27 - Subject 8, total number times hands used in reaching for objects.

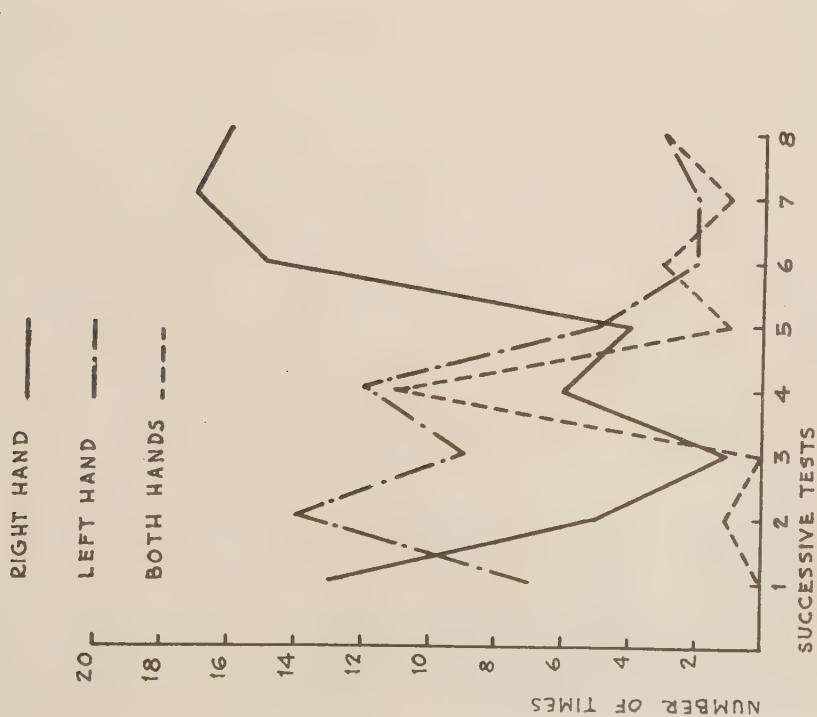


Fig. 26 - Subject 6, total number times hands used in reaching for objects.

TABLE VI

COMPARATIVE USE OF THE HANDS IN REACHING FOR OBJECTS PRESENTED MEDIANLY, SUBJECTS 5 - 8

| Subject        | Period    | Hand Used |          |          | No. Trials |
|----------------|-----------|-----------|----------|----------|------------|
|                |           | Right (%) | Left (%) | Both (%) |            |
| <u>5</u> ..... | Total.... | 58        | 31       | 11       | 147        |
| <u>7</u> ..... | Total.... | 24        | 60       | 16       | 110        |
| <u>6</u> ..... | I ....    | 32        | 53       | 15       | 79         |
|                | II ....   | 72        | 17       | 11       | 71         |
|                | Total.... | 51        | 36       | 13       | 150        |
| <u>8</u> ..... | I ....    | 12        | 60       | 28       | 95         |
|                | II ....   | 67.5      | 17.5     | 15       | 80         |
|                | Total     | 37        | 41       | 22       | 175        |

It was impossible to secure additional records of the spontaneous activity of the hands of Subject 8, but the child's mother gave tests for the use of the hands in reaching for objects a month later (August 29 to September 7) and right-dominance was then indicated, as shown in the last part of Fig. 27.

The results of the tests of this subject for the use of the hands in reaching for objects are shown in terms of percentages in Table VI, Period I including the tests given during the left-dominant interval, and Period II including the tests given later by the child's mother and showing right-dominance.

If only the reaching records of Subjects 6 and 8 were available, and if these records had not been continued sufficiently long to show the shift back to right-dominance, the inevitable conclusion to be reached would be that at this stage no definite hand preference is indicated. When the reaching records are shown in proper time sequence and the accompanying records of spontaneous manual activity are included in the picture, however, the situation at once takes on a different light. A left-dominant phase is distinctly apparent and a shift from that back to right-dominance is also clearly evident. To what extent other such shifts may still occur, of course, cannot be prophesied for these particular infants. Certainly there had been earlier shifts, described in the last section, and that the shift occurring at this later level is more extreme than the ones occurring at the earlier levels is indicated by the spontaneous activity record. It might, therefore, be argued that these infants could still become permanently left-dominant.

When these records are viewed in the light of the records of the older subjects described in Chapter II and those of the other subjects of this group, however, the general outlines of the genetic development of lateral dominance seem to fall into a definite pattern -- a pattern whose exact form varies with individuals, but which is characterized by differentiation between the two hands beginning at least as early as these tests were begun, modified by periodic fluctuations which in some cases are minor and cause only about equal activity of the hands for a period, as in the case of Subject 3 in the earlier investigation and of Subject 5 of this group, and in other cases are more severe, resulting in actual dominance of the other

side for a period, as in the case of Subject 1 and Subjects 6 and 8. Fitting into this pattern, also, would be the individual cases in which the dominance of either side of the body is so minor that no definite trend is established until a somewhat later period, in some cases never. Subject 4 of the preliminary investigation suggests this type of individual.

Notes taken during observation periods.- Facts concerning the direction of light, position of the child, and any significant character in the child's movements were noted during each test period, and pages 84 - 102 of the appendix show these notations in outline form.

Analysis of these notes indicates no apparent relationship between the position of the child and the comparative amount of hand movement, nor between direction of the light and comparative amount of manual activity.

The hands, of course, were never allowed to be restricted, as the observations could not have been carried on in that situation. Some degree of restriction of one arm or the other occurred quite occasionally, however, without affecting the spontaneous activity records. The more active hand was that of the more restricted arm approximately as often as it was that of the unrestricted arm. Of the 49 instances in which one arm was somewhat restricted, 21 cases show the hand of the unrestricted arm to have been the more active, while 20 cases show the hand of the restricted arm to have been the more active, and 8 cases give no difference in amount of activity of the two hands in these circumstances.

It is also interesting to note that of the 49 times in which the infants were turned somewhat on one side, it was the left side in 26 instances and the right side in 23 instances, showing that as far as this test series is concerned, neither side was favored in this respect.

Concerning the possible relationship between the direction of the light and turning of the infant's head toward the side, the notes reveal the fact that of the 164 days on which the direction of the light is given (in a few cases the direction of the light was not noted) the light fell upon the child from the right side 25 times and the left side 22 times, as compared with 117 instances in which the direction of the light was from the foot of the bed, from behind the head, or so generally diffused and subdued as to be considered equal from all directions. This fact automatically excludes the possibility that direction of the light could have influenced head turning, either as an attracting or as a repelling force.

A significant tendency noted during the observations is that toward a greater spontaneous activity not only of one hand but also of the corresponding side of the body. The only objective evidence to substantiate this statement lies in the notes concerning head turning and in the moving picture records of the infants' behavior, and neither of these, of course, is sufficiently representative to be considered on a level with the evidence secured concerning differences in amount of spontaneous manual activity.

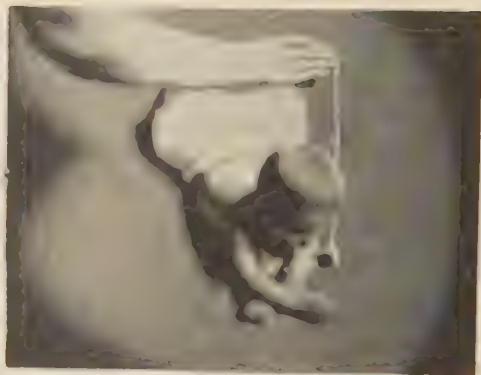
With regard to head turning, the notes are not so full as they would have been had the significance of this tendency on the part of the infants been realized earlier in the study. The following numerical data are available, however.

|                         | Head turned R | Head turned L | No.<br>Cases |
|-------------------------|---------------|---------------|--------------|
| R-dominant infants..... | 60%           | 40%           | 28           |
| L-dominant infants..... | 38%           | 64%           | 28           |

It should be specified that "head turning" includes only those instances when the remainder of the body lay straight and the position of the head

## PLATE IV

SUBJECTS 5 AND 8, SIX MONTHS OF AGE, REACHING FOR BLOCK



Subject 5, right dominant.      Subject 8, right dominant.  
Right hand reaching for block, left arm supporting weight.



could therefore be changed by the child, himself. Even as early as the second day of life several of the subjects of the supplementary investigation showed the ability to turn the head from side to side, when lying on their backs.

The number of instances of head turning noted above is not sufficiently large to be conclusive, but the possibility of a relationship between greater activity of one hand and greater tendency to turn the head toward the side of that hand is certainly suggested.

The mother of left-dominant Subject 7 reported that turning the head toward the left was characteristic of the child, while in the observation notes (date 3-10, p. 84) it will be seen that on one occasion right-dominant Subject 5's head was forcibly turned left but both times the baby turned his head back toward the right.

Other aspects of this side-dominance are found in the thumb and finger sucking (see Plate III), holding the hand out in front of the body, comparative activity of the legs and feet (see Plates III, VII and VIII) and direction of rolling (see Plate V).

Subject 5, right-dominant, sucked his right fingers consistently. When he began holding his hands out in front of his face, his right hand seemed to be held up and looked at more than his left. His right leg seemed more active, indicated particularly when he began grasping his feet in his hands. It was noted that the fact that he succeeded in grasping his right foot with his right hand before he was able to do the same with his left, seemed to be not only because his right hand grasped more successfully than his left, but also because his right foot was lifted higher than his left foot. Due, apparently, to this greater activity of the right side, this child rolled consistently toward the left when rolling first began.

In the case of Subject 7, left-dominant, exactly the same picture was presented, but in connection with the opposite side of the body. This child sucked the fingers of his left hand, held his left hand out in front of his face more than his right hand, his left leg was impressively more active than his right, he succeeded in grasping his left foot in his left hand earlier than his right foot in his right hand, and when first beginning to roll, he rolled consistently toward the right side. See Plates VII and V.

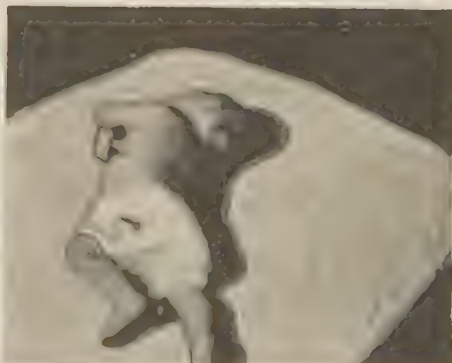
In connection with the characteristic attitude of "looking at the hands," it will be seen from the notes on Subject 6 (date 6-1, p. 88), and Subject 7 (date 6-3, p. 89) that when the less active hand began to be held out in front of the face the effect of "looking at the hand" was no longer present as had been the case when the dominant hand was held out in the earlier stage.

This suggests interesting possibilities concerning eye-coordination. One possibility, of course, is that the infant only appears to be looking at his hand in the earlier stage, due to the fact that the head tends to turn in the direction of the dominant side of the body. When the hand of that side is then held out in front, but somewhat to the side, with the head turned toward that side, the eyes and hand are in line with one another and the gaze thus appears to be fixated on the hand. When the other hand is held out, unless the head changed its direction of turning, it is not in line with the eyes and no appearance of fixation is present.

Another possibility is that the infant does actually fixate the hand when the hand is in line with the eyes and that he fixates the dominant hand, therefore, because his head is turned in that direction, but does not look at the non-dominant hand, for the same reason.



## PLATE V

SUBJECTS 5 AND 7, SIX MONTHS OF AGE, ROLLING

Subject 5, right dominant, rolling  
toward left.

Subject 7, left dominant, rolling  
toward right.

If this second suggestion holds true, the thought suggests itself that in this early asymmetrical training in eye-coordination, asymmetrical in that the hand while held in front of the face is also inevitably held somewhat toward the side, may be found the cause of eye-dominance.

It should be added that these several manifestations of greater activity of one side of the body than of the other show themselves most distinctly in the first stages of the development of a particular skill. It was when the hands were first held out in front of the body that Subject 5's right hand and Subject 7's left hand dominated most definitely. After a time, the other hand was also held out in front of the child. It was in the early stages of playing with the feet that Subject 5's right foot and Subject 7's left foot were more successfully grasped than were their mates. Later the other foot also came into the picture. Likewise, it was the early efforts at rolling that showed definite tendency to roll in one direction, only. After rolling had become a usual part of the baby's activity it could be and was performed in both directions.

It is possible that had records been taken in this connection, a greater amount of activity in these particular coordinations on the dominant side might still have been shown even after the skill was developed in both directions. The general impression gained from watching the babies was that this was so, but this impression cannot be verified by objective evidence. That these skills were first acquired on the dominant side, however, can be stated as a fact.

An interesting situation which substantiates the foregoing theory is found in the case of Subject 6's thumb sucking. This habit seemed to be taken on quite suddenly by this infant, and the time at which it was first manifested was at the close of a period during which her left hand had been more active than her right. This may be verified by the notes for this subject on dates 4-17 to 5-8 of the note outline, p. 87. The mother commented upon the suddenness of the child's acquisition of the thumb sucking habit, as the fact that this baby had not sucked her fingers at all, prior to this time, had been remarked upon. It was the left thumb which was first sucked, and it was this thumb which continued to be sucked throughout the test series, even though the general record of the baby is definitely right-dominant, and in spite of the fact that the finger sucking which soon developed was almost entirely of the right hand.

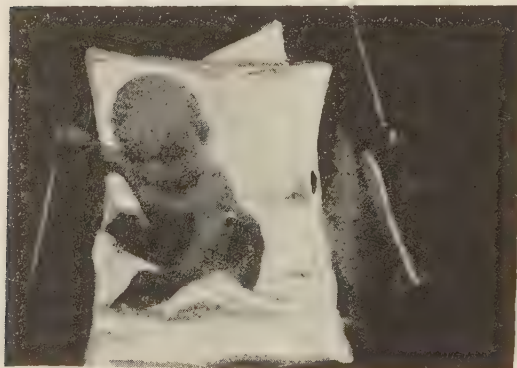
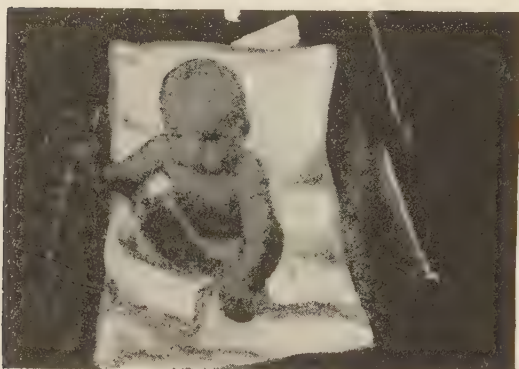
The suggestion, then, seems to be that thumb sucking, because it set in at a time when the left side was more active than the right, became an established habit in connection with the left hand and remained so in spite of the fact that all the other crucial performances of this child favored the right side.

An interesting exception to the picture described above is Subject 8, who manifested this general side dominance less in proportion to his hand dominance than did any of the other infants.

From the time when leg movements were first noted carefully (this group of infants, Subjects 5, 6, 7, 8 and 9, it will be remembered, were born in January, and were kept covered rather heavily during the first three months) it was seen that this child, instead of flexing his knees, extended them rigidly so that leg "activity" in this case meant maintained extension rather than alternate extension and flexion, as was the case with the other subjects. No differences were noticeable in amount of activity of the legs of this subject, as this extension seemed always to occur simultaneously in the two legs. When rolling began, he seemed to push himself over with the soles of his feet and seemed to roll toward both sides indiscriminately. The method of initiating the rolling movement, used by the other two subjects observed in this connection (Subjects 5 and 7), involved heightened activity of the leg (strenuous kicking) and of the arm of the dominant

## PLATE VI

SUBJECT 7, SIX MONTHS OF AGE, SITTING UP AND MANIPULATING COVER



Left dominant, left hand manipulating cover,  
right hand holding side of carriage.

side which seemed to swing the child toward the non-dominant side.

That the method of instituting the falling movement differs with different infants was noted through further observation of this activity. As has been stated, Subjects 5 and 7 of this study seemed to swing themselves into the movement through heightened arm and leg activity, and rolled toward the side opposite the more active side, while Subject 8 pushed himself over by pressure of his feet against the surface on which he was lying, and since his leg activity was not differentiated as was that of the other two subjects, rolled in either direction.

Another infant, not included in this study, was found to initiate the rolling movement in the upper part of his body. His head was characteristically turned toward the right side; his chest seemed to heave toward that side, and the lower part of his body was practically thrown over, following the upper body action. This child was observed carefully during the earliest stages of rolling (at four months of age) and was found to roll only toward the right, his more active side at this time.

Thus, three distinct methods of rolling were found, each of them more or less related to lateral differentiation, or to lack of it, as in the case of Subject 8.

To continue with the characteristic behavior of Subject 8, as will be seen from the notations for date 4-21, p. 91, the first tendency of this child, with respect to holding the hands out in front of the face, was to hold both hands out at the same time. Although he did not suck his fingers much, when he did suck them he seemed to show no particular preference for either hand.

Inspection of the notes on this particular infant show that his position during the observations was less frequently straight and more frequently on one particular side, the left, than was the case for any of the other subjects.

The possibility suggests itself that the spontaneous hand activity records for this particular child might, after all, have been affected by this situation. The right hand dominance indicated in the activity record may be greater than it should be, and, in that case, the apparent lack of side dominance in the other activities described might be consistent rather than inconsistent with the theories outlined.

Another possibility, however, is that the several manifestations of lateral dominance, i.e., differences in hand activity, in leg activity, or in activity of other parts of the musculature of the two sides of the body may each vary in degree, which situation itself might contribute to the appearance of differences in degree of side dominance as a whole.

To summarize, the following findings are based on the supplementary notes taken during the observations and on the information gleaned through long contact with the several infants.

There is no apparent relationship between the direction of the light and comparative manual activity, nor between direction of light and turning of the head.

There is no apparent relationship between the position of the child and comparative amount of spontaneous hand movement, unless the record of Subject 8 may be considered to have been somewhat prejudiced in this way.

There is evidence of dominance of one entire side of the body, indicated not only by greater activity of one hand than of the other, but also by greater activity of the leg of the dominant side, by turning of the head



toward the dominant side, holding the dominant hand out in front of the body more than the non-dominant hand, grasping the foot in the dominant hand earlier than in the non-dominant hand, and rolling toward the non-dominant side, when the rolling is instituted by greater activity of the arm and leg of the dominant side, and toward the dominant side when the activity is instituted by the upper part of the body.

There is evidence that this lateral dominance is expressed particularly in the early stages of the acquisition of skills such as those described. It may be further expressed in the more frequent performance of the skill on the side on which it was first acquired, as in the case of Subject 6's thumb sucking, and as indicated by the general impression of continued greater activity of the preferred side in all the skills described.

An interesting possibility concerning the early development of eye-dominance is suggested in the tendency of the infant to turn the head toward the side on which the hand is first held out in front of the body, bringing about either the appearance of fixation or the actual fixation of the eyes on that particular hand more than on the hand of the non-dominant side.

Finally, differences in degree of side dominance are suggested by the case of Subject 8, whose leg movements were of a different type than were those of the other subjects, and who did not show a favoring of one side in the development of the various skills corresponding to his lateral dominance in spontaneous manual activity.

Family histories of hand dominance.— Inquiry into the family history of hand dominance, so far as it is known by the mothers of the subjects, reveals the following.

Subject 5, Baby Bruce -- no history of left-handedness in ancestry, but one brother and one sister (deceased), left-handed. The sister had been sickly from birth and died at four years of age. The left-handed brother has a speech disturbance, very poor muscular coordination, and is retarded in his school work. Two other brothers and a sister all right-handed, are normal in every way, as is also Baby Bruce.

Subject 6, Baby Joan -- no history of left-handedness, so far as is known.

Subject 7, Baby Charles -- Father's twin sister, left-handed.

Subject 8, Baby Dan -- Mother's two brothers, and mother's two uncles and one cousin, all left-handed.

Subject 9, Baby Oscar -- Father and mother's brother, both left-handed.

Subject 10, Baby Christine -- Mother considers herself ambidextrous now, although was left-handed in childhood.

Subject 11, Baby William -- Father's mother, left-handed.

### Conclusions

1. Analysis of the results of tests of the comparative amount of spontaneous activity of the two hands of seven subjects, tested over a period extending from two weeks of age to from four to eight months of age, indicates differentiation between the two hands. In four cases this differentiation favors the right hand, in three cases the left hand.

The differentiation between the hands, while showing a total trend favoring one hand, is modified by more or less extreme transferences which occur at sufficiently consistent age levels in the several subjects to



suggest a definite periodicity in lateral dominance.

In all seven cases a distinct and consistent period of lateral dominance is shown, beginning at periods varying from the sixth to the fourteenth week. More or less identical shifts occur in the records of the subjects prior to this main period of lateral dominance, and recur in two of the four cases observed beyond the six months age level at about the twenty-fifth week.

2. When tests to determine the comparative use of the hands in reaching for objects were given to the four subjects whose records were continued beyond the age of six months, the results were found to be in agreement with the results of the tests for comparative amount of spontaneous activity of the hands.

The spontaneous activity records of two of the subjects at this time show the right hand to have been dominant in one case and the left hand in the other, and the records for the use of the hands in reaching for objects give the same results for these two subjects.

The other two subjects were in a shift period at the time the tests for reaching were instituted and both favored the previously non-dominant hand in spontaneous activity and also in reaching for objects. One of these two subjects very soon shifted back to her original dominance, the right, in her use of the hands in reaching and also in her spontaneous manual activity, while the other subject (Subject 8, whose case has been discussed in detail) indicated a return to right dominance in the last part of the test series and also in additional tests which were carried out by the mother a month later, that is, during the baby's eighth month of age. In this supplementary testing by the mother, however, records for reaching, only, were secured for this subject.

The comparative amount of spontaneous activity of the two hands is thus shown to be in general agreement with the comparative use of the hands in reaching for objects.

3. No relationship between the comparative amount of spontaneous manual activity and either the position of the child or the direction of the light during the period of observation is found when the group is considered as a whole. The possibility that the records of one subject may have been affected by the frequent restriction of one arm, however, has been suggested.

4. There is evidence that lateral dominance concerns the body as a whole rather than merely the hands, differences in activity of the legs, arms and upper trunk all being indicated.

5. There is evidence to indicate that lateral dominance plays an important part in the early stages of the acquisition of motor skills in young infants.

6. Individual differences in degree of lateral dominance are indicated and it is suggested that the several elements making up side dominance may vary in degree in the same individual.

7. The possibility of some relationship between the apparent or real fixation of the eyes on the hand of the dominant side (perhaps due to the fact that the head is more often turned toward that side) and the development of eye-dominance is suggested. The possibility that eye-dominance may be another aspect of general lateral dominance should not be overlooked however.

8. Nothing of definite significance seems to be available concerning a hereditary factor in lateral dominance.

Of the four right-dominant subjects, in the case of only one is there no known instance of left-dominance in the family history. This is Subject 6. Subject 11 has one grandmother known to be left-handed; Subject 8 gives a history of a number of cases of left-handedness in his mother's family, i.e., the mother's two brothers, her two uncles and one cousin; while Subject 5 has one left-handed brother and had one left-handed sister, although no cases are known in his ancestry.

Of the three left-dominant subjects, Subject 7 has a left-handed aunt, twin sister of his father; Subject 9 reveals left-handedness in both sides of his family, his father and his mother's brother both being described as very left-handed; while the mother of Subject 10 reports herself to have been distinctly left-handed in childhood and now practically ambidextrous.

Two impressions gained from the foregoing statements are, first that left-handedness seems to be somewhat more prevalent in this group of families than might have been expected, and, second, that the incidence of left-handedness is as great in the families of the right-dominant as in those of the left-dominant subjects. Closer analysis, however, suggests other possibilities.

In the first place, discussion of Subject 8's case has brought out the possibility that this subject may be considered less right-dominant than the other members of the right-dominant group. If this should be accepted as significant and if Subject 8 should therefore be eliminated from the right-dominant group, the number of left-handed relatives of the right-dominant subjects would be at once greatly reduced, since this subject's family history fairly teems with left-dominants.

In the second place, the left-dominance of Subject 5's brother and deceased sister might possibly be linked with their rather considerable physical defects and be of the "phenotypical" variety described by Ludwig, which is to be differentiated from "genotypical" or hereditary left-dominance.

By "special phenotypical inversion" is meant that that which has been accomplished through cruder methods in the case of forced or pathological inversion can also occur with less intensity as a result of injury during the early embryonic stage. There is no proof of the existence of this type of inversion in the case of man, but if one finds in the case of Ascaris that through increased temperature, or in the case of Seeigellarven, through change in the salt content of the medium, artificial inversions can be brought about, and that many animal right-left characters are found to show phenotypical inversion, the possibility of the same type of inversion in man should be accepted. Analogous to other right-left characters, the whole side preference, as well as its parts, such as hand preference, may be inverted.<sup>1</sup>

Taking into consideration the foregoing modifications of the bare statistical facts, a slightly different picture is presented, showing some possibility of the presence of a hereditary factor in lateral dominance.

<sup>1</sup> Ludwig, op. cit., p. 353.

## CHAPTER IV

### SUPPLEMENTARY STUDY

The main body of the investigation having indicated a possibility of differentiation between the two hands even in the first month of life, a supplementary study was undertaken to determine whether or not such differentiation may also be found during the first week to ten days following birth.

#### Subject Group

Again Dr. Adair gave his sanction to the study and again the kindest cooperation was given by officials of Chicago Lying-in Hospital, Miss Kelting, superintendent of nurses, and Mrs. Andrews, in charge of the nurseries in which the study was conducted, gave all necessary assistance.

Babies pronounced normal at birth and giving an appearance of good sound physique were selected, with the exception of one abnormal case to be described later.

Random selection again chiefly determined the choice of subjects. Of the sound, normal infants available in the particular nursery at the particular time they were needed, one or two at a time were selected on the basis of convenience of location of the beds in the nursery plus, perhaps, some prejudice on the part of the experimenter concerning the appearance of the infant.

Subject 12 -- Boy baby Winslow, born July 2nd, was observed from July 4th through July 10th, that is, from two to eight days of age.

Subject 13 -- Boy baby Brundage, born July 2nd, was observed from July 4th through July 10th, that is, from two to eight days of age.

Subject 14 -- Girl baby Bergen, born July 3rd, was observed from July 4th through July 12th, that is, from one to nine days of age.

Subject 15 -- Boy baby Ruelle, born July 12th, was observed from July 13th through July 18th, that is, from one to six days of age.

Subject 16 -- Girl baby Halloran, born July 19th, was observed from July 20th through July 25th, that is, from one to six days of age.

Subject 17 -- Boy baby Solomon, born July 11th, was observed from July 14th through July 19th, that is, from three to eight days of age. This subject had an abnormal condition of the right hand, although apparently normal in every other respect. The hand, wrist and arm of the right side were slimmer than those of the left side and the digits of the right hand included only the thumb and two fingers. There was no gap between the thumb and finger nor between the two fingers, as the reduced width of the wrist and hand simply allowed for no more digits than those present. The left hand was normal.

#### Method of Procedure

Schedule of observations.-- Observations of these subjects took place in the nurseries of Chicago Lying-in Hospital, all necessary precautions having been taken by the experimenter so that entree to the nursery was permissible.

Subjects were observed daily, with the exception of the omission of one day's testing of Subject 16. All observation periods lasted from thirty-six to seventy-two minutes of actual observation, with the exception of one day on which Subjects 12, 13 and 14 were observed for periods of only eighteen minutes each. An attempt was made to accumulate samplings as large as possible of each infant's activity during the short period of time through which these subjects were observed.

Details of procedure.— All observations of these subjects were confined to timing of spontaneous activity of the hands of the subjects, according to the technique adopted in the earlier investigations. Each observation period, although more extended in length, was, nevertheless, divided into intervals similar to those used with the earlier subjects, i.e., three periods of six minutes each, during which observation of the two hands alternated every sixty seconds. One such eighteen minute period made up an integral part of each day's testing, and in most instances three such parts made up the entire observation for the day. In the exceptional case mentioned, only one eighteen minute observation was made, and in a few other cases the length of the observation was extended to four parts.

Supplementary notes were taken with regard to the position of the infant, the direction of the light, and any general impressions of the experimenter, particularly as to the accuracy of the recorded data. Due to the fact that the movement of young infants is more or less spasmodic, there were instances when the true situation was not revealed by the timing records, in spite of the extended length of the observation periods which was instituted in order to eliminate this weakness in the technique as far as possible.

Moving picture records of the activity of a new-born infant were also taken, the first pictures at sixteen hours, the next at forty-eight hours and the last at four days of age.

## Results

Timing of the manual activity (see Figs. 28 and 29), together with records of head turning and close observation of the behavior patterns of these six subjects indicate a definite difference in the amount of activity of the two sides of the body in four cases and the possibility of similar differences in the remaining two cases.

Table VII gives the results in terms of the number of days during which one or the other side of the body of each subject was more active, both according to the timing records and according to the extended observation of the experimenter during the timing periods. This table also gives the number of days during which the head was turned toward one side or the other, while the infant lay on his back. On occasions when the infant was lying on his side, records of head turning, of course, are not available.

In Table VIII the same information is given, but with the subjects classified into two groups, those showing greater right activity and those showing greater left activity. In addition, the results for each group are totaled and percentages of comparative right and left activity are shown.

Details of the notes taken during the observations of this youngest group of infants are found in outline form in the appendix, pp. 95-102, and are the records upon which the results under "observational notes" in Tables VII and VIII are based.

These several records, taken together, indicate a greater activity of the right side for Subjects 14 and 15, and of the left side for Subjects 12 and 16. Subjects 13 and 17 are somewhat doubtful, but seem to show some indication of greater activity of the right side.



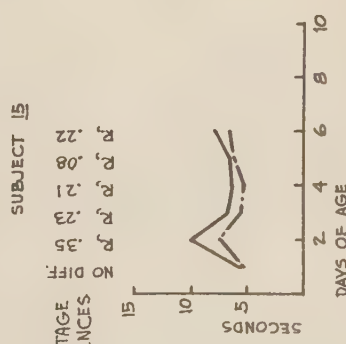
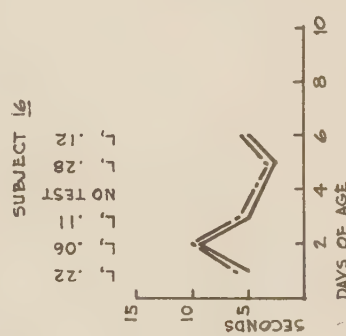
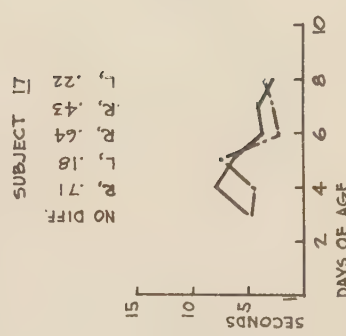
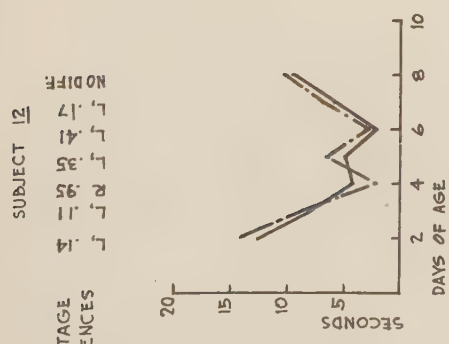
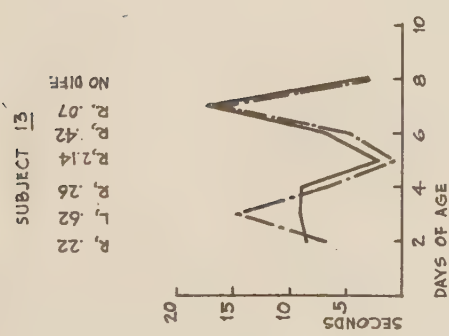
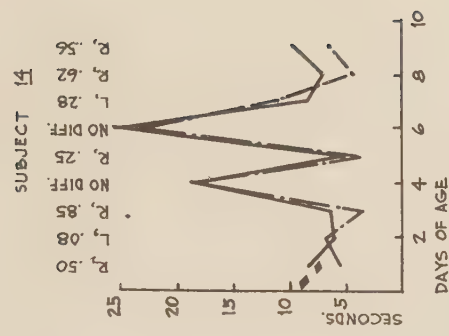


FIG. 28 - Average amount per minute spontaneous activity of hands, subjects 12-17. Percentage differences favoring R or L hand indicated, less than 5% arbitrarily called no difference.



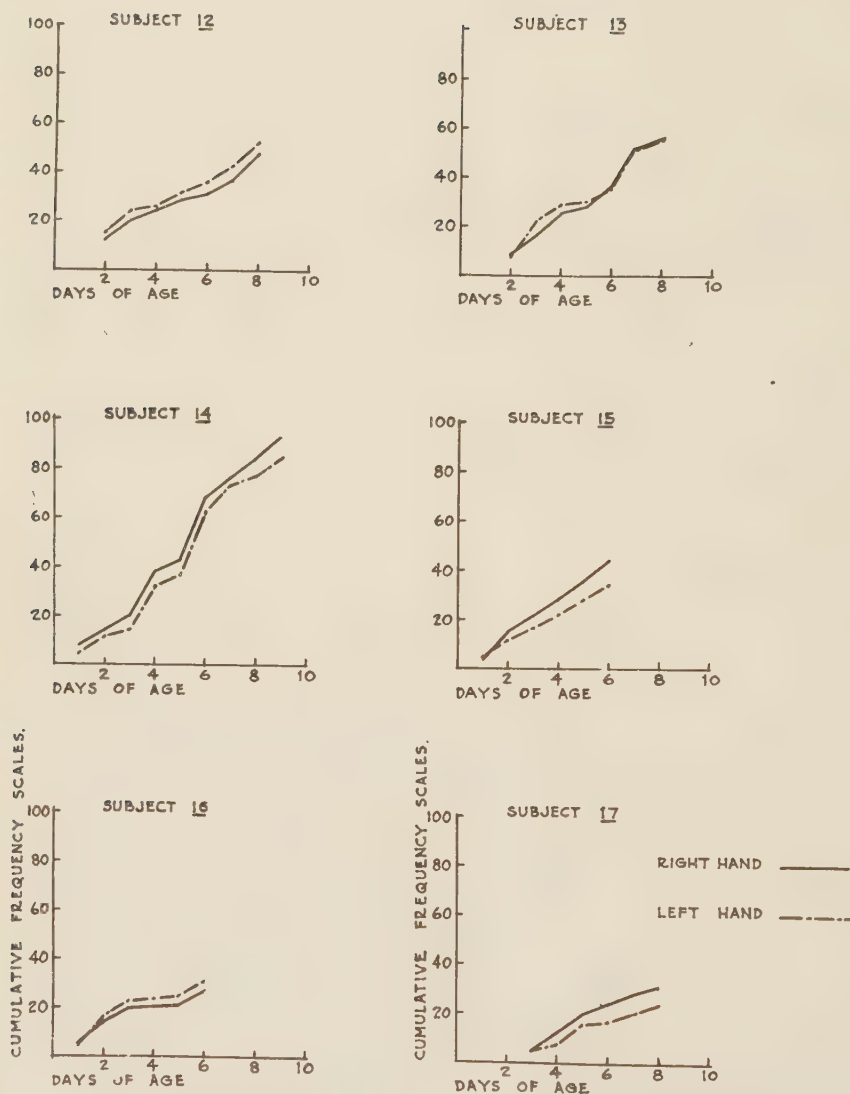


Fig. 29 - Cumulative frequency curves for spontaneous activity of hands, Subjects 12 - 17.

TABLE VII

SUMMARY OF DAILY RECORDS, SUBJECTS 12 - 17, SHOWING NUMBER OF DAYS EACH HAND MOST ACTIVE AND NUMBER OF DAYS HEAD TURNED TOWARD SIDE

| Subject         | Hand Most Active<br>(No. Days) |   |      |                        |   |      | Head Turned<br>(No. Days) |   |
|-----------------|--------------------------------|---|------|------------------------|---|------|---------------------------|---|
|                 | Timing Records                 |   |      | Observational<br>Notes |   |      |                           |   |
|                 | R                              | L | Same | R                      | L | Same | R                         | L |
| <u>12</u> ..... | 1                              | 5 | 1    | 1                      | 4 | 2    | 1                         | 4 |
| <u>13</u> ..... | 5                              | 1 | 1    | 4                      | 1 | 2    | 2                         | 2 |
| <u>14</u> ..... | 5                              | 2 | 2    | 6                      | 2 | 1    | 6                         | 2 |
| <u>15</u> ..... | 5                              | 0 | 1    | 6                      | 0 | 0    | 4                         | 2 |
| <u>16</u> ..... | 0                              | 5 | 0    | 0                      | 5 | 0    | 1                         | 3 |
| <u>17</u> ..... | 3                              | 2 | 1    | 5                      | 1 | 0    | 4                         | 2 |

TABLE VIII

SUMMARY OF DAILY RECORDS, SUBJECTS 12 - 17, GROUPED ACCORDING TO GREATER RIGHT AND GREATER LEFT ACTIVITY

| Most<br>Active Subject<br>Side |                 | Hand Most Active<br>(No. Days) |    |      |                        |    |      | Head Turned<br>(No. Days) |    |
|--------------------------------|-----------------|--------------------------------|----|------|------------------------|----|------|---------------------------|----|
|                                |                 | Timing Records                 |    |      | Observational<br>Notes |    |      |                           |    |
|                                |                 | R                              | L  | Same | R                      | L  | Same | R                         | L  |
| Right                          | <u>13</u> ..... | 5                              | 1  | 1    | 4                      | 1  | 2    | 2                         | 2  |
|                                | <u>14</u> ..... | 5                              | 2  | 2    | 6                      | 2  | 1    | 6                         | 2  |
|                                | <u>15</u> ..... | 5                              | 0  | 1    | 6                      | 0  | 0    | 4                         | 2  |
|                                | <u>17</u> ..... | 3                              | 2  | 1    | 5                      | 1  | 0    | 4                         | 2  |
|                                | Total No.       | 18                             | 5  | 5    | 21                     | 4  | 3    | 16                        | 8  |
|                                | %.....          | 64                             | 18 | 18   | 75                     | 14 | 11   | 67                        | 33 |
| Left                           | <u>12</u> ..... | 1                              | 5  | 1    | 1                      | 4  | 2    | 1                         | 4  |
|                                | <u>16</u> ..... | 0                              | 5  | 0    | 0                      | 5  | 0    | 1                         | 3  |
|                                | Total No.       | 1                              | 10 | 1    | 1                      | 9  | 2    | 2                         | 7  |
|                                | %.....          | 8                              | 83 | 8    | 8                      | 75 | 17   | 22                        | 78 |

Discussion of results.- The records of head turning and the notes taken during observation periods indicate that here, as with the subjects of the investigation dealt with in the last chapter, head turning and leg activity supplement manual activity in the expression of difference in degree of activity of the two sides of the body. See Plates VII and VIII.

Also, as in the earlier investigation, records of direction of the light during observation periods indicate no relation between head turning and direction of light, nor between difference in manual activity and direction of light. Using the eighteen minute "parts" of the observation periods as units, in order to secure a larger sampling, the following results are obtained.

|                              |                     | No.<br>Cases | %  |
|------------------------------|---------------------|--------------|----|
| Direction of light           | ) same side.....    | 29           | 34 |
| Greater activity of one hand |                     |              |    |
| Direction of light           | ) opposite sides... | 26           | 30 |
| Greater activity of one hand |                     |              |    |
| Light from foot.....         |                     | 31           | 36 |
| Direction of light           | ) same side.....    | 31           | 35 |
| Head turned                  |                     |              |    |
| Direction of light           | ) opposite sides... | 27           | 30 |
| Head turned                  |                     |              |    |
| Light from foot.....         |                     | 31           | 35 |

Again it should be noted that the technique used in this investigation has a definite weakness due to the fact that the movement of very young infants is of a spasmodic nature and timing of the hands separately will occasionally give results which do not conform to the real activity pattern. If both hands could be timed simultaneously the results would be more satisfactory.

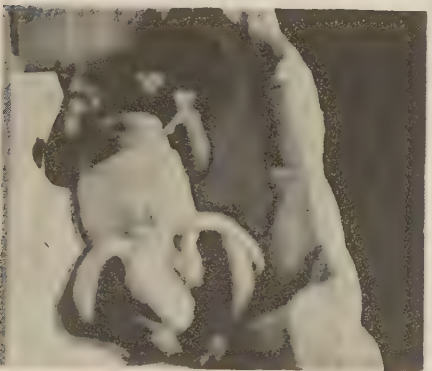
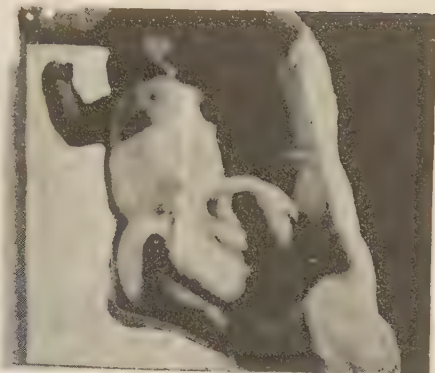
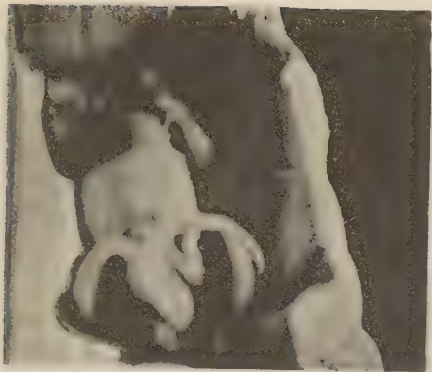
It was hoped that the extended length of each day's observation period of these subjects would serve to meet this difficulty to a considerable degree, and that this is true is shown by the extent to which the differences favoring one or the other hand according to the timing records conform to the differences according to the observational notes. See Table VII. That there are discrepancies, however, is shown by the same records, and in the case of Subject 17 the discrepancies are so great that the subject appears to show no differentiation between the activity of the two hands according to the timing records, while he shows a distinct favoring of the right hand according to the observational notes.

This infant, Subject 17, is the one whose right hand was abnormal, having only three digits instead of five, but this abnormality seemed to make no difference in the relative activity of the hands. One might have been led to think that, since much of the movement differentiating the two hands is finger movement the lack of two fingers would lower the activity record of that hand. The observational notes indicate clearly, however, that the right was the more active hand except on the last day of observation, and the discrepancies between the observation notes and the timing records are due to the fact that on two of the six days of observation the left hand activity was heavily over-weighted through the occurrence of more simultaneous activity of the two hands during periods when the left hand was being timed than during periods when the right hand was under observation.

Subject 13, the other subject whose records are somewhat confusing, was placed definitely on his side by the nurses during most of the observation periods, in contrast to the position of the other infants who were placed on their backs practically throughout the time of the observations. For this reason, head turning records were less often available. Their absence should be accounted for by the position in which the infant was lying during most of the observation periods, rather than by a lack of the tendency to turn the head, although whether or not there would have been a favoring of one side or the other in this activity had more records been available cannot, of course, be determined.

That the record for this same subject (see Fig. 28) on the third day of age (second day of observation), which shows the left hand more active than the right, is not an accidental matter is shown by the notes for that day (date 7-5, p. 96). There was a remarkable amount of activity of the left arm and hand on that occasion, which was not duplicated by the right arm and hand. The baby was lying on his right side, during that particular

## INFANT SIXTEEN HOURS OF AGE

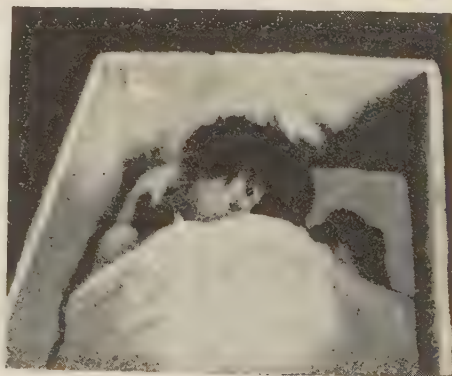


Head turned right. Right hand in fanning movement. Left hand much less active and feet quiet.

Head turned right. Right foot in motion. Left foot quiet.

## PLATE VIII

## INFANT FORTY HOURS AND FOUR DAYS OF AGE



Forty hours of age. Head turned right. Right foot in motion. Left foot quiet.

Four days of age. Head turned right. Right fingers in motion. Left hand quiet.



period, but on the preceding day his position had also been on the right side, yet his right hand had been the more active, so it is difficult to say whether or not the result was affected by the position in which the child was lying. In any case, the high left hand activity for that one observation period weights the cumulative curves (Fig. 29) for this subject's activity very heavily, giving the left hand an appearance of supremacy which disappears when the curves are examined closely. Inspection of the relationship of the two curves from that day on shows a closing together with a final crossing of the two, and this really represents the same relationship between the activity of the two hands which in the cumulative curves for the other subjects is represented by a spreading apart of the two curves.

A final word of emphasis should be placed on the observation that the bulk of the difference in activity of the hands of young infants is to be found in the small movements of the fingers, wrists, toes and ankles. Usually, when large arm and leg movements appear the activity spreads throughout the body and no differentiation is present between the two sides, while much small finger, wrist, toe or ankle movement of one side, independent of the other, is noticeable.

Most interesting to note is the seeming spread of activity, when small movements, initiated in the fingers of one hand or the toes of one foot, gradually develop into large arm and leg movements with simultaneous action in both sides of the body. In other instances the activity may be initiated in the mouth region, where sucking movements occur without any apparent external stimulus, followed by small hand or foot movements, which, in turn, spread into large-muscle, general activity.

#### Conclusions

1. Timing of the manual activity of infants from one to nine days of age indicates the presence of a differentiation between the two hands even at this early age.
2. Observed differences in the amount of activity of the feet and legs and records of the direction of head turning suggest that at this age level, as later, manual differentiation may be only one aspect of a differentiation between the two sides of the body.
3. Observation of the activity patterns of these young infants reveals the fact that differentiation shows itself particularly in the small-muscle movements, i.e., of the fingers, wrists, toes and ankles, although independent activity of the two arms and the two legs is also seen.
4. Indication of a "spread" of excitation is suggested in the frequent instances where movement seemed to be initiated in a small area, such as the mouth region (sucking movements) or the digits of one hand or foot, and gradually to spread to larger muscle groups until all four extremities and the head, as well, may be vigorously in action. This behavior pattern was often observed when no apparent outside stimulus had occurred, that is, no sound had been heard, nor had there been change in the intensity or direction of the light nor in the position of the infant.
5. The number of cases dealt with in this study is, of course, too small to warrant any conclusion regarding the incidence of right and left-dominance, but the presence of two cases of greater left activity in a total of six cases, following upon the appearance of several left-dominant subjects in the preceding studies of this investigation, suggests the possibility of more left-dominance in infancy than that generally found among adults.

## CHAPTER V

### DISCUSSION

The findings of this investigation, while suggesting conclusions concerning the nature and genesis of hand preference which differ radically from those that have been suggested by other experimenters, may be reconciled rather neatly with most of the findings of other studies.

Watson's study.— To take the matter up chronologically, a number of obvious points may be made in connection with the studies conducted by Watson.

In the first place, measurements right and left anatomical structures of new-born infants could hardly be expected to show significant differences, with only crude measuring devices available and with so small a number as twenty cases.

Moreover, according to the following quotations, anthropologists seem to believe that differentiation of anatomical structure develops only with age.

At the time of birth the length of the bones in the two arms is identical. In other words, the asymmetry manifests itself in the course of post-embryonic life.<sup>1</sup>

If the newer and later estimates of the prevalence of left-handedness are accepted and it is admitted that education may play a part, which varies in each individual, in modifying the original relations of the bones to one another, then the humerus may be taken as giving some general indication of the handedness of the skeleton to which it belonged.<sup>2</sup>

In the second place, while the use of time of suspension as an index of differentiation between the two hands might offer interesting possibilities in line with the theory of differentiation in amount of activity of the two sides of the body presented in the present study, Watson's discussion of his data in this connection is unsatisfactory and inadequate. The record of only one subject is given, without any indication as to the results for the other nineteen subjects.

Although this particular record does show a difference favoring the left hand in time of suspension, Watson says no differentiation is indicated because there is no "constancy in time of suspension from day to day."<sup>3</sup> Why constancy in time of suspension should be used as the criterion of differentiation is certainly difficult to determine.

Finally, Watson's description of his method of measuring amount of work done indicates that here the very type of activity, namely, small-muscle activity, which in the present investigation was found to be the chief source of differentiation, did not enter into the system of measurement.

For this work we use an especially devised work adder. This in principle is an escapement wheel that works in such a way that no matter how the baby slashes its arms about it turns the wheel always in one direction. As the wheel revolves it winds up a small

<sup>1</sup> G. Elliott Smith, "Right and Left-handedness in Primitive Man," British Medico. J., II (December 12, 1925), 1107.

<sup>2</sup> L. B. Wevill, "The Occipital Bones and the Bones of the Superior Extremity in Relation to Right and Left-handedness," Edinburgh Medico. J., XXXV (1928), 12.

<sup>3</sup> John B. Watson, Behaviorism, p. 130. Revised; New York: W. W. Norton and Company, 1930.

Chart I <sup>4</sup>

Showing daily record of results on the two hands:

| Age<br>in<br>Days | Time of suspension<br>(in seconds) |      | Work done on adders<br>(in inches) |       |
|-------------------|------------------------------------|------|------------------------------------|-------|
|                   | Right                              | Left | Right                              | Left  |
| 1                 | 1.2                                | 5.6  | 16.16                              | 13.75 |
| 2                 | 2.2                                | 3.0  | 25.00                              | 15.00 |
| 3                 | .6                                 | 1.4  | 37.50                              | 36.25 |
| 4                 | .6                                 | .4   | 12.00                              | 15.00 |
| 5                 | 1.2                                | 1.0  | 15.00                              | 27.00 |
| 6                 | 1.0                                | 1.6  | 17.16                              | 16.00 |
| 7                 | .6                                 | 3.2  | 21.25                              | 29.37 |
| 8                 | 1.0                                | 2.2  | 24.16                              | 18.37 |
| 9                 | 1.8                                | 1.8  | 17.25                              | 13.00 |
| 10                | 1.4                                | .6   | 28.00                              | 9.00  |
| Average           | 1.16                               | 2.08 | 21.34                              | 19.27 |

lead weight attached to the wheel by a cord. The hands of the baby are then attached. His slashing movements begin to wind the ball up. Usually the baby lies naked on its back, unstimulated by the observer. At the end of 5 minutes the baby is taken out of the apparatus and the height in inches of the two weights above the table is measured.<sup>5</sup>

Voelckel's investigation.— In respect to Voelckel's investigation, in which he found no difference in the use of the right and left hands for reaching before seven months of age, a number of comments may be made.

The subject group used by Voelckel was made up of infants from the children's clinic at the University of Munich, largely convalescents, he says, or under treatment for feeding difficulties. In such case, it might be possible for the group as a whole to be slightly retarded, when compared to a physically normal group of infants.

Again, examination of Voelckel's data for the six months old group suggests that throwing together individual records of this type is not entirely satisfactory.

On the following page is a portion of the table given by Voelckel, in which he shows the results for each individual in his entire test group.<sup>6</sup>

It will now be seen that of the seven cases between six and seven months of age, three show no difference, one shows extreme right-dominance, one distinct left-dominance and two some left-dominance. It seems hardly representative of this group, then, to state that no differentiation is present at this age level, simply because lumping data of this type together neutralizes the effect of those cases which do actually reveal lateral dominance.

Finally, Voelckel's results show such extreme right-dominance, after dominance does set in, that one is led to wonder whether his technique was

<sup>4</sup> Ibid., p. 131.

<sup>5</sup> Ibid., pp. 130-131.

<sup>6</sup> Ernst Voelckel, "Untersuchungen über die Rechtshändigkeit beim Säugling," Zeitschrift für Kinderheilkunde, VIII (1913), 354.

| No.<br>(Subject) | Age in months | No. trials | Right | Left | Both |
|------------------|---------------|------------|-------|------|------|
| 11               | 6             | 48         | 22    | 26   | -    |
| 12               | 6             | 50         | 24    | 24   | 2    |
| 13               | 6             | 50         | 21    | 28   | 1    |
| 14               | 6             | 46         | 24    | 22   | -    |
| 15               | 6½            | 50         | 45    | 5    | -    |
| 16               | 6½            | 50         | 20    | 30   | -    |
| 17               | 6½            | 50         | 23    | 21   | 6    |

When these results are converted into percentages, the following table may be constructed.

| Subject | Age<br>(Months) | Hand Used in Reaching |           |           | Dominant Hand |
|---------|-----------------|-----------------------|-----------|-----------|---------------|
|         |                 | Right<br>%            | Left<br>% | Both<br>% |               |
| 11      | 6               | 46                    | 54        | -         | Somewhat Left |
| 12      | 6               | 48                    | 48        | 4         | No difference |
| 13      | 6               | 42                    | 56        | 2         | Somewhat Left |
| 14      | 6               | 52                    | 48        | -         | No difference |
| 15      | 6½              | 90                    | 10        | -         | Right         |
| 16      | 6½              | 40                    | 60        | -         | Left          |
| 17      | 6½              | 46                    | 42        | 12        | No difference |

entirely satisfactory. His description of the method of presenting objects to the infants is the following.

An object was therefore held before the child, who lay on his back in his bed, within reaching distance and so situated as to be equally distant from each hand. It was then noted with which hand the child reached.<sup>7</sup>

Nothing is said with regard to the manner in which the object was held before the child. Neither is mention made of any sort of change in technique for older children. One wonders whether the object may always have been presented in the experimenter's right hand. If so, the results would surely have been weighted in favor of the right hand for those subjects older than about nine months.

Experiments conducted by Baldwin and Woolley.- Concerning both Baldwin's and Mrs. Woolley's findings, it is interesting to note that, while the total series in each study gives no hand preference for either subject, analysis of the data gives a somewhat different picture.

Taking up Baldwin's study first, the following table of results for tests for easy reaching is given by him.<sup>8</sup>

| Date                | No. of<br>Series | No. of<br>Experiments | Right<br>Hand | Left<br>Hand | Both<br>Hands |
|---------------------|------------------|-----------------------|---------------|--------------|---------------|
| Feb. 10 - March 15  | 30               | 744                   | 173           | 166          | 405           |
| March 14 - April 14 | 25               | 623                   | 134           | 141          | 348           |
| April 14 - May 14   | 25               | 546                   | 213           | 130          | 203           |
| May 14 - June 19    | 16               | 274                   | 57            | 131          | 86            |

<sup>7</sup> Ibid., p. 353.

<sup>8</sup> James Mark Baldwin, Mental Development in the Child and the Race, Methods and Processes, p. 60. New York: The Macmillan Company, 1895.

These results indicate that neither hand was favored during the seventh or eighth months, but that the right hand dominated during the ninth month, and the left hand during the tenth month.

It will be seen that right-dominance during the ninth month, with a shift to left-dominance during the tenth month, is in complete accord with the findings in the present investigation for Subjects 1 and 2 (Chapter II). Fig. 30 gives another graphical representation of Subject 1's transference from right to left-dominance and back to right at this age level.

It will also be recalled that similar shifts occurred in the cases of Subjects 6 and 8 of this investigation at the six and seven months age level (Chapter III). Fig. 31 shows this shift in the case of Subject 6.

It is possible, then, that the data which Baldwin has grouped by months from February 10 to April 14 may be concealing a similar transference at an earlier period, and that had the daily records been given, a general right-dominant trend with periodic shifts to left-dominance might have been revealed.

Mrs. Woolley suggests this very situation when she says that, for the test series which she gave during her child's seventh month, the records favoring the left hand were secured almost altogether during the first week of the month, the right hand predominating steadily after that.<sup>9</sup> Yet, because the series as a whole showed no difference, the conclusion was reached that at this time there was no differentiation between the two hands. Why such an artificial time interval as the month should have been used by these experimenters as a basis for classifying their results is difficult to see.

Concerning Mrs. Woolley's results, which indicated a favoring of the object placed in the right-side position, as against that placed in the left-side position, on the surface it would appear that here is a real disagreement between the older study and the present investigation, since no such extreme favoring of either position is found for Subjects 1, 2 or 3. The following table gives the results for these subjects in this connection.

TABLE IX

RELATIVE CHOICE OF RIGHT AND LEFT POSITION WHEN TWO OBJECTS ARE PRESENTED AT ONCE

| Subject  | Period       | Position Chosen |     |      |     | Total No. Trials |
|----------|--------------|-----------------|-----|------|-----|------------------|
|          |              | Right           |     | Left |     |                  |
|          |              | No.             | %   | No.  | %   |                  |
| <u>1</u> | I            | 34              | 51* | 32   | 48* | 66               |
|          | II           | 63              | 47  | 71   | 53  | 134              |
|          | III          | 34              | 53  | 30   | 47  | 64               |
|          | Total Series | 131             | 50  | 133  | 50  | 264              |
| <u>2</u> | Total Series | 38              | 51  | 36   | 49  | 74               |
| <u>3</u> | Total Series | 34              | 54  | 29   | 46  | 63               |

<sup>9</sup> Helen Thompson Woolley, "Development of Right-handedness in a Normal Infant," *Psych. Rev.*, XVII (January, 1910), 37.



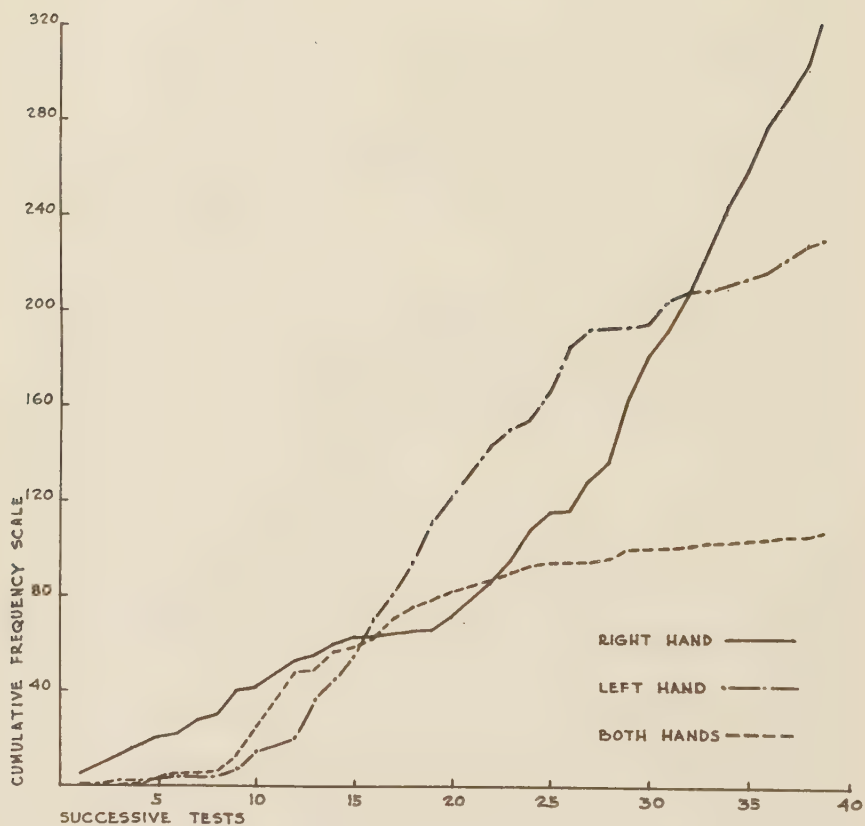


Fig. 30 - cumulative frequency curve for use of hands in reaching for objects in controlled experimental situation - Subject 1 age 8 through 12 months.

More careful analysis, however, reveals that all three of Subjects 1, 2 and 3 were older at the time of these tests than was Mrs. Woolley's small subject when he was tested, and as has been noted earlier, the tendency to secure both objects, when two are presented at once, increases with age. The youngest of the three subjects of this study, Subject 3, who was nine and ten months of age at the time of these tests, as compared to Mrs. Woolley's son, who was seven months of age when tested, gives a slight favoring of the right-side position. As has also been observed before, this child chose both blocks at once only a small number of times, while the older subjects, 1 and 2, chose both blocks at once in a large majority of the trials. The very fact of taking only one object when two are presented at once is, then, a matter of immaturity.

Furthermore, when Subject 1's record is analyzed into periods, as is done in Table IX, there does seem to be some relation between position chosen and hand dominance even in this older child. The differences are very small, but the fact that the right-side position is slightly preferred during right-dominant Period I, the left-side position during left-dominant Period II, and the right-side position again during right-dominant Period III may have some significance, even though the total series shows no difference in this respect.

The eldest of the three subjects, Subject 2, shows no significant difference in his choice of objects, and as a matter of fact chose both objects at once in a large majority of the trials.

When it is recalled that Mrs. Woolley's child was really right-dominant, and that, had she analyzed her data for hand used in reaching in sequence this would probably have been revealed, the choice of the right-side position would here, too, be in agreement with hand dominance.

Biographical material.— Although only in the nature of an opinion, additional evidence of transference in dominance is to be found in the records kept by Dearborn and also by Mrs. Fenton.

It will be remembered that Dearborn stated that his child gave evidence of apparent left-handedness before right-hand preference was established, being recorded as "very left-handed" on Day 168. This would be slightly before the six months age level, or slightly earlier than the transference shown by Subjects 6 and 8 of this study. By the tenth month, the child was described as definitely right-sided. It is interesting to note Dearborn's reference to the more ready use of the right leg as well as the right arm at this later age.<sup>10</sup>

Jessie Chase Fenton, on the other hand, makes reference to what must have amounted to a transference similar to that of Subject 3 (Chapter II) when she says her child was definitely right-handed by the 30th week and has remained so ever since, although "for a time in his 11th and 12th months the left hand came near to catching up."<sup>11</sup>

Bethe's study and discussion.— Finally, it seems appropriate to take up Bethe's position in the matter of lateral dominance in infancy, since the premises on which he bases his arguments against right and left-handedness as inherited characters and as connected with left and right cerebral dominance, respectively, are in direct opposition to the findings of this study, both as to time of the appearance of hand dominance and also as to its nature.

<sup>10</sup> G. V. N. Dearborn, Moto-sensory Development, p. 31. Baltimore: Warwick and York, 1910.

<sup>11</sup> Jessie Chase Fenton, A Practical Psychology of Babyhood, p. 95. New York: Houghton Mifflin Company, 1925.

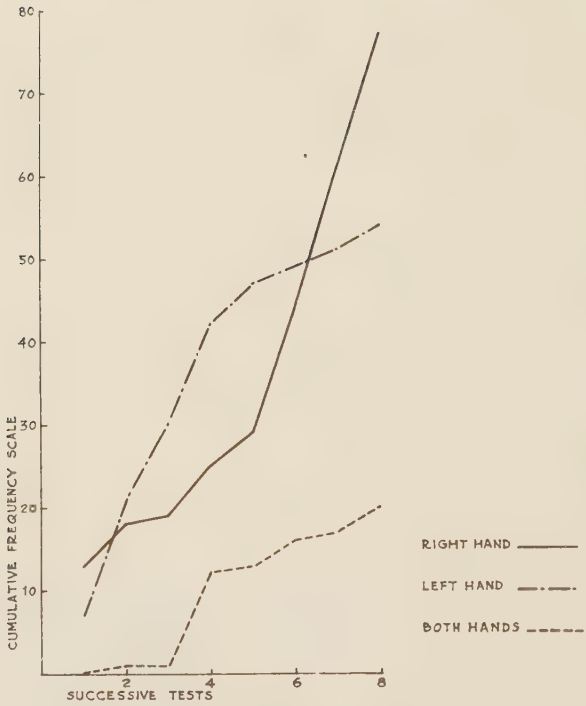


Fig. 31 - Cumulative frequency curve for use of hands in reaching for objects in controlled experimental situation - Subject 6, during 7th month of age.

Bethe<sup>12</sup> begins by stating the generally accepted theory that there is a relationship between the greater use of one side of the body and the better functional development of the opposite half of the brain.

He goes on to say that most authors assume this to be an innate relation, some even postulating inheritance in Mendelian ratio with only two factors, right and left, but that as a matter of fact, since all the larger studies of hand preference have been of more or less mature subjects who have been exposed for some time to all the external influences tending to bring about right-hand preference, it is quite possible that only a very small part of mankind is either right or left-dominant by nature, the great majority being indifferent in this respect but gradually becoming right-sided through training and experience.

In order to test this matter, Bethe conducted a study of hand preference, using 95 children ranging from two to six years of age, and testing them for the use of the hands in the following situations: shaking hands, eating with a spoon, pointing at objects with the finger, reaching for symmetrically placed bonbons, picking up objects from the floor, building with pebbles and cutting with scissors.

Nothing is said in the article concerning the method of scoring the results of these tests, except that a child was called right or left-dominant when that hand, only, was used, or almost altogether; as "left greater than right," or vice versa, when one hand was used more than the other; and as "left equals right" when no definite tendency could be determined.

The following table<sup>13</sup> gives Bethe's results according to this somewhat unreliable method of measurement, and shows approximately the type of distribution that Bethe had anticipated for the earlier age level.

| Age         | L    | L > R | L = R | R > L | R    |
|-------------|------|-------|-------|-------|------|
| 2 - 4 years | 16.7 | 23.8  | 21.4  | 21.4  | 16.7 |
| 4 - 6 years | 17.0 | 1.9   | 5.7   | 24.5  | 51.0 |

On the basis of this study, then, Bethe argues that there must be only a loose and indirect relation between right-handedness and left-brainedness, and also between right-handedness and the fact that the speech centers are located in the left hemisphere of the brain, since right-handedness is so late a development in the individual.

It would be easy, so Bethe continues, to understand the possibility of the development of the side of the brain opposite the preferred hand through activities which are carried out unilaterally, but is difficult to see why this should find expression through an activity which in all its aspects is so entirely bilateral as is that of speech. It is therefore worth considering the possibility that the localization of the speech center in one particular hemisphere is to a greater extent innate than is the case with the one-sided motor centers. The influence of the former on the latter would then be only secondary.

It is also necessary, according to Bethe, to consider the fact that only in the case of a few individuals is one hand used sufficiently more than the other to warrant the theory that one hemisphere will be more developed than the other through the activity of the preferred side of the body. The definitely unilateral activities, such as eating soup and throwing stones,

<sup>12</sup> Albrecht Bethe, "Zur Statistik der Links- und Rechtsaendigkeit und der Vorherrschaft einer Hemisphaere," Deutsche Medizinische Wochenschrift, LI (1925), 681-683.

<sup>13</sup> Ibid., p. 682.

play a relatively minor role in the lives of most persons, so that the strong dominance of the left hemisphere, which has been definitely established, can hardly be explained in this way.

Furthermore, the writer continues, in this connection should be mentioned Liepman's findings that in cases of aphasia among children of  $2\frac{1}{2}$  to 5 years of age, at which time there can be in most cases no talk of a definite hand preference, the seat of the lesion is still in the majority of cases in the left hemisphere.

What we learn is not action of one hand, so Bethe goes on, or one arm, but, rather, action patterns in which not only the other arm but the entire body plays some part. It is easier to assume that such total patterns have their origin in one place in the cerebrum than that they are divided between the two hemispheres according to the division of the right and left sides of the body.

If one hemisphere already has the supremacy, it is altogether plausible that it also takes up activities in which the extremities of the same side may play a leading role; that, as Liepman says, in the case of a right-handed person, everything or a part of everything that the left hand can do is governed by the left hemisphere. If this were not so, then it would be impossible to understand why activities performed by the right hand can be learned more easily by the left hand than they were originally learned by the right hand. If a wholly new center had to be developed in the opposite hemisphere the very same steps would have to be covered.

For one-handed activities, a unitary origin in the cerebrum seems requisite. Whether it is right or left is perhaps unimportant.

Bethe closes by saying that in our brains the origins seem to be located preeminently on the left side, but the relationship between this localization and the preference for the use of the right hand seems not sufficiently explained, since in only a small number of individuals is this preference for the right hand something primary, in the majority of persons it is the result of external influences.

That differentiation between the two hands has not been found at an earlier age level in most studies, however, in the present writer's opinion is due to the fact that the use of the hands in relatively skillful actions, such as reaching for objects, has been used as the criterion for hand dominance. Since unilateral reaching develops only after a certain level of maturity has been attained, differentiation between the two hands, when judged by this method, could not possibly find expression any earlier than this same age level.

Should hand preference, however, be conceded to be only one aspect of a sidedness which shows itself to a greater or lesser degree from birth on, then all of Bethe's arguments against hand preference as linked with cerebral dominance could be turned to favor that very theory. Rather than a "loose and indirect relation between right-handedness and left-brainedness .... since right-handedness is so late in developing," a very close relation might be postulated to be present, since lateral differentiation, when measured by yard-sticks which can be applied at the earliest age levels, is so apparent in the motor activity of infancy.

Where Bethe uses the fact that a majority of cases of aphasia in children from  $2\frac{1}{2}$  to 5 years of age show lesions in the left hemisphere, as evidence that lateral dominance in the brain is probably innate, while hand-preference is acquired, the present writer prefers to offer another interpretation. If the findings of the present investigation may be given any credence, then hand-preference has a physiological basis in a differentiation between the two sides of the body which finds expression in the activ-



ity of other muscle groups as well as in those which control the activity of the fingers, hands and arms. Since this differentiation is seen from the earliest age level studied, namely, the first ten days of life, then it would seem justifiable to assume its origin to be some functional differentiation within the nervous system which is either innate or which has begun its development during intra-uterine life, -- which, in Bethe's own words, then, is something primary.

## CHAPTER VI

### CONCLUSION

In order to present a complete picture of this investigation of the early manifestations of lateral dominance, the following summary of the conclusions reached through the three separate studies is offered.

That there is a differentiation between the two hands throughout the period from birth to seventeen months of age is shown by records of the comparative amount of spontaneous activity of the two hands of infants observed during this age period.

Observation of young infants, ages sixteen hours to three and four months, reveals the fact that the greatest differentiation between the hands at this earlier age level lies in the activity of the small-muscle groups, i.e., those of the fingers, wrists, toes and ankles.

Records of the manual activity of older infants, approximately six to seventeen months of age, show that there is a positive relationship between differences in amount of spontaneous activity of the two hands and the preferential use of the hands in reaching for objects, indicating that greater spontaneous activity of one hand and greater use of the same hand in reaching for objects are related phenomena.

Records of head turning and observation of other typical behavior patterns through the total age period indicate a differentiation in amount of activity, not only of the two hands but also of the musculature of the legs, trunk and head. This is revealed by the fact that head turning toward the dominant side, greater activity of the leg of the dominant side, and direction of rolling are related with greater activity of the hand and arm of the dominant side expressed in amount of spontaneous movement, hand and finger sucking, and reaching for objects.

The theory is therefore advanced that all of these differentiations are related aspects of the same thing, namely, sidedness or lateral dominance.

In addition to the foregoing results which bear on the important question of the general nature of hand preference, a number of other interesting facts are disclosed.

While the general trend is toward manifestation of lateral dominance in practically the whole musculature of the body, there is also evidence of transfers in dominance in the individual developmental history, apparently occurring at fairly definite age levels, noticeably during the seventh month of age and again at the ten months age level. Furthermore, evidence is given to indicate the presence of individual differences in degree of lateral dominance, both with regard to amount of differentiation between the two sides and extent of differentiation in the several aspects of lateral dominance.

There is also some evidence to indicate that lateral dominance, as expressed in greater activity of one side of the body, plays an important role in the early stages of the acquisition of the typical motor skills of early infancy, namely, head turning, finger sucking, holding the arm and hand out-stretched in front of the body, putting toe into mouth, rolling, and, finally, reaching for and securing objects with the hand.

Typical of the manual activity of the infant is the use of the non-dominant hand for purposes of support. When support is not needed, the non-dominant hand is often entirely motionless, while the dominant hand is actively in use.

These findings, when reviewed together, suggest the theory that hand preference, recognized in children and adults as the more skillful and preferred use of one hand, may have a physiological basis in the tendency toward greater activity in one side of the body, and also a psychological basis in the greater amount of practice and training received by the hand of the dominant side due to its more frequent use in the early development of manual skills.

The possibility that eye dominance may have a partial basis in the training in fixation which the eye of the dominant side receives through the tendency of the hand of that side to be held out as an object of fixation is suggested.

No conclusive evidence concerning the presence of a hereditary factor in lateral dominance can be offered by this study, but analysis of the individual case histories lends some support to Ludwig's theory of the possibility of two types of left-handedness, genotypical and phenotypical.

The surprisingly large number of left-dominant cases in so small a group, namely, six of a total of seventeen, or approximately 35%, suggests the presence of a greater incidence of left-dominance in infancy than might have been expected from the results of investigations of left-dominance in childhood and maturity.

## APPENDIX

## NOTES TAKEN DURING OBSERVATIONS

Key: R - right

L - left

H - head

F - foot

G - general

S.res. - slightly restricted

SUBJECT 5

| Date | Light | Position                                                | Most Active | Remarks                                                                                                                           |
|------|-------|---------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 2-14 | R     | L. arm s. res.                                          | L           |                                                                                                                                   |
| 2-15 | H     | Straight                                                | R           |                                                                                                                                   |
| 2-16 | R     | Head R                                                  | R           |                                                                                                                                   |
| 3-7  | -     | Straight                                                | R           |                                                                                                                                   |
| 3-9  | G     | Straight                                                | R           | Sucking R fingers - also sucked L, but R much more.                                                                               |
| 3-10 | G     | Head R                                                  | R           | E twice turned baby's head to L, but baby turned it back R both times.                                                            |
| 3-13 | G     | Straight                                                | R           | Sucking R fingers - head turned R last part.                                                                                      |
| 3-14 | G     | First part on mother's lap - then straight on bed.      | L           | L arm restricted during nursing, but movement largely hand and finger movement.                                                   |
| 3-15 | G     | Head R - R arm s. res.                                  | L           |                                                                                                                                   |
| 3-17 | F     | Straight                                                | Same        | Head turned R last part, sucking R fingers.                                                                                       |
| 3-27 | G     | Head L                                                  | R           |                                                                                                                                   |
| 3-30 | G     | Head L                                                  | R           | Entirely independent movement of the two hands during sleep.                                                                      |
| 4-3  | G     | Straight                                                | Same        | Head turned R last part - sucking R fingers.                                                                                      |
| 4-6  | G     | Straight first part, then nursing, then straight again. |             | L arm more restricted while nursing, but during this time L hand was more active than R. R hand more active while lying straight. |

| Date | Light | Position                              | Most Active | Remarks                                                                                                                                         |
|------|-------|---------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 4-10 | F     | Straight                              | Same        |                                                                                                                                                 |
| 4-13 | -     | Straight                              | R           |                                                                                                                                                 |
| 4-17 | G     | Straight                              | R           |                                                                                                                                                 |
| 4-20 | F     | Head R - then L                       | R           | Sucking R fingers, then sucking L fingers.                                                                                                      |
| 4-27 | H     | Straight                              | R           | Somewhat larger movements of R than of L.                                                                                                       |
| 5-1  | H     | Straight                              | Same        |                                                                                                                                                 |
| 5-4  | H     | Head R and L Interchangeably.         | Same        | Sucked L hand for first time, then changed back to R. Seems to be holding R hand out in front of self, looking at it, and using L to feel of R. |
| 5-8  | H     | Straight                              | Same        |                                                                                                                                                 |
| 5-11 | H     | Straight                              | Same        | R movements more vigorous than L.                                                                                                               |
| 5-15 | G     | Straight                              | Same        | Sucking R fingers.                                                                                                                              |
| 5-25 | G     | Head L first part.                    | R           | R larger movements.                                                                                                                             |
| 6-1  | F     | Straight                              | R           | Played with box part of time and grasped it and even seemed to reach for it with R only.                                                        |
| 6-5  | F     | Straight                              | R           | Sucked L thumb during part of time.                                                                                                             |
| 6-8  | G     | Lying on floor, rolling and creeping. | Same        | Rolls over to R side, takes R foot in R hand -- rolls to L side and takes L foot with R hand.                                                   |
| 6-12 | G     | Lying on floor, rolling and creeping. | R           |                                                                                                                                                 |
| 6-20 | -     | Lying on floor, rolling and creeping. | Same        | Rolls toward L and takes R foot into both hands, putting toe in mouth. Only R foot put into mouth - rolls always toward left.                   |
| 6-28 | G     | Lying on floor                        | Same        |                                                                                                                                                 |
| 7-25 | -     | Lying on floor                        | R           |                                                                                                                                                 |
| 7-26 | -     | Lying on floor                        | R           |                                                                                                                                                 |
| 7-27 | -     | Lying on floor                        | R           |                                                                                                                                                 |



| Date | Light | Position       | Most Active | Remarks |
|------|-------|----------------|-------------|---------|
| 7-28 | -     | Lying on floor | Same        |         |
| 7-29 | -     | Lying on floor | Same        |         |

SUBJECT 6  
(Baby girl Joan)

|      |   |          |   |                                                                                                                                                                                                                                                                                                                |
|------|---|----------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-24 | L | Straight | L | Arm movements even in this young infant are only somewhat symmetrical - posture of arms at rest usually fairly symmetrical but movements between rest periods not necessarily balanced. When have movement of one arm usually have some movement of the other, but not necessarily the same in kind or amount. |
|------|---|----------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Note: This was the first observation on a young infant.

|      |   |                                   |      |  |
|------|---|-----------------------------------|------|--|
| 1-25 | L | Head s. L                         | R    |  |
| 1-26 | L | On L side<br>L res.               | R    |  |
| 1-27 | L | Somewhat on L<br>side - L res.    | L    |  |
| 1-30 | F | Straight                          | R    |  |
| 1-31 | L | Head turned L                     | R    |  |
| 2-1  | L | Head s. L                         | L    |  |
| 2-2  | R | Somewhat on R<br>side - R res.    | R    |  |
| 2-20 | H | Somewhat on R<br>side - R s. res. | R    |  |
| 2-21 | L | Straight                          | R    |  |
| 2-23 | R | Straight                          | L    |  |
| 2-24 | F | Somewhat on R<br>side - R s. res. | L    |  |
| 2-27 | G | Straight                          | Same |  |
| 2-28 | G | Straight                          | Same |  |
| 3-1  | R | Straight                          | L    |  |
| 3-2  | H | Head s. R                         | Same |  |
| 3-21 | R | Head R                            | L    |  |
| 3-22 | R | Head R                            | R    |  |

| Date | Light | Position                | Most Active | Remarks                                                                                                                                                                    |
|------|-------|-------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3-23 | F     | Straight                | R           |                                                                                                                                                                            |
| 3-27 | R     | Head R                  | R           |                                                                                                                                                                            |
| 3-30 | F     | Straight                | R           |                                                                                                                                                                            |
| 4-4  | F     | Head R                  | R           |                                                                                                                                                                            |
| 4-6  | F     | Head R                  | R           |                                                                                                                                                                            |
| 4-10 | F     | Straight                | L           |                                                                                                                                                                            |
| 4-13 | F     | Head L                  | Same        | Was lying on davenport and watching shadow of L arm on back of davenport.                                                                                                  |
| 4-17 | F     | Head R                  | Same        | Sucking R fingers - then L fingers. Had practically never sucked fingers before. Seemed in all to suck L more than R.                                                      |
| 4-20 | F     | Straight                | R           | Sucking L thumb - Mother reports has just started this.                                                                                                                    |
| 4-24 | F     | Straight                | R           | Seems to watch R hand more than L - puts fingers or thumb of L hand in mouth however.                                                                                      |
| 4-28 | F     | Head R                  | R           | Still sucking L thumb, otherwise less active than R. Keeps R hand extended out at arms length great deal of time - seems to be watching it.                                |
| 5-1  | F     | Straight                | L           | Sucking L thumb and finger, but looking at R hand, holding it out in front of face. General activity of R greater than L, but thumb sucking of L increases latter's score. |
| 5-4  | F     | Head alternated R and L | R           | Still watches R hand - sucked L thumb great deal, but also sucked R hand a little.                                                                                         |
| 5-8  | F     | Head R part of time     | Same        | Sucking R fingers during first period - larger arm movements of L during second period - L thumb into mouth, and watching R hand.                                          |
| 5-11 | F     | Straight                | R           | Still waves R around in front of face, looking at it - still sucks L.                                                                                                      |
| 5-22 | F     | Head s. R               | R           | Holding L hand out in front more than before.                                                                                                                              |
| 5-25 | L     | Head L                  | R           | Looking at L hand good deal.                                                                                                                                               |

| Date | Light | Position | Most Active | Remarks                                                                                                                                                                                      |
|------|-------|----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6-1  | F     | Straight | R           | Sucking R fingers - holding L hand out in front, but does not seem to be watching it - may therefore not have been watching R hand either.                                                   |
| 6-5  | F     | Straight | L           |                                                                                                                                                                                              |
| 6-8  | F     | Straight | R           | Seems to be looking at L hand extended out in front. Grasping R foot with R hand - clasps L hand on L leg but does not really grasp L foot.                                                  |
| 6-16 | F     | Straight | Same        |                                                                                                                                                                                              |
| 6-19 | L     | Head L   | L           | Much L thumb sucking. Mother reports baby to be L much more than R just now.                                                                                                                 |
| 6-22 | L     | Head L   | R           | Reaching for feet. Did not grasp either foot but manipulated R foot with R fingers, while L fingers did not get as far as L foot. This is partly because R leg was lifted higher than L leg. |
| 6-27 | L     | Straight | R           |                                                                                                                                                                                              |
| 7-27 |       |          | L           |                                                                                                                                                                                              |
| 7-28 |       |          | L           |                                                                                                                                                                                              |
| 8-1  |       |          | L           |                                                                                                                                                                                              |
| 8-2  |       |          | L           |                                                                                                                                                                                              |
| 8-4  |       |          | Same        |                                                                                                                                                                                              |
| 8-14 |       |          | R           |                                                                                                                                                                                              |
| 8-16 |       |          | R           |                                                                                                                                                                                              |
| 8-18 |       |          | R           |                                                                                                                                                                                              |

SUBJECT 7  
(Baby boy Charles)

|      |   |                       |      |                                   |
|------|---|-----------------------|------|-----------------------------------|
| 2-13 | L | Straight              | R    |                                   |
| 2-14 | G | On L side -<br>L res. | R    | Movement largely finger movement. |
| 2-16 | L | Head R                | R    |                                   |
| 2-17 | L | Head R                | Same |                                   |
| 3-6  | L | Head R                | Same |                                   |

| Date | Light | Position                          | Most Active | Remarks                                                                                                                                    |
|------|-------|-----------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 3-9  | R     | Straight                          | Same        |                                                                                                                                            |
| 3-10 | -     | Straight                          | Same        |                                                                                                                                            |
| 3-13 | R     | Head s. L -<br>R s. res.          | Same        | Left fingers in mouth.                                                                                                                     |
| 3-14 | G     | Head L                            | L           |                                                                                                                                            |
| 3-15 | F     | S. on L side -<br>L s. res.       | R           |                                                                                                                                            |
| 3-16 | H     | Head L                            | Same        | Mother reports baby turns own head toward L, no matter which way he is placed.                                                             |
| 3-17 | G     | Head L                            | L           | Sucking L fingers.                                                                                                                         |
| 3-27 | R     | Head R<br>R s. res.               | Same        |                                                                                                                                            |
| 3-29 | R     | Head L                            | Same        | Sucking L fingers - put R fingers to mouth once but did not suck them.                                                                     |
| 4-18 | R     | Head L                            | R           | Sucking L fingers most of time.                                                                                                            |
| 4-21 | L     | Head turned L,<br>later turned R. | L           | L arm waved in larger, more active movements.                                                                                              |
| 4-26 | G     | Straight -<br>L s. res.           | L           |                                                                                                                                            |
| 4-29 | G     | Head L                            | L           | Baby asleep - action largely finger and hand movement.                                                                                     |
| 5-4  | -     | Straight                          | Same        |                                                                                                                                            |
| 5-10 | R     | Straight                          | Same        |                                                                                                                                            |
| 5-15 | G     | Straight                          | L           | Sucked R hand some, but also L. Mother reports has been sucking R.                                                                         |
| 5-18 | Front | Straight                          | L           |                                                                                                                                            |
| 5-24 | -     | Straight                          | L           | Looking at hands - seems to look at L hand most.                                                                                           |
| 5-26 | R     | Straight                          | Same        | Sucking L fingers.                                                                                                                         |
| 5-31 | G     | Straight                          | Same        | Sucking L fingers.                                                                                                                         |
| 6-3  | F     | Straight, but<br>L s. res.        | Same        | Held R hand out good deal of time but did not seem to be looking at it. L fingers in mouth much of time, but R fingers once or twice, too. |

| Date | Light | Position                   | Most Active | Remarks                                                                                                                                                                                     |
|------|-------|----------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6-10 | G     | Straight, but<br>L s. res. | Same        | Sucking L fingers.                                                                                                                                                                          |
| 6-14 | G     | Straight                   | L           |                                                                                                                                                                                             |
| 6-16 | G     | Straight                   | Same        | Seemed to watch L hand<br>more - sucked L fingers - but<br>clutched at dress with R hand.                                                                                                   |
| 6-20 | F     | Turned s. R -<br>R s. res. | L           | Movements altogether of re-<br>flex type - L decidedly more<br>active than R - much twitching<br>of L arm and L leg - none of<br>R leg. Once had twitch of L<br>leg and R fingers together. |
| 6-23 | G     | Lying on floor             | L           | Not rolling over yet, but<br>tending to roll toward R. L<br>leg extremely active while R<br>leg almost motionless.                                                                          |
| 6-27 | G     | L arm s. res.              | L           | Is not yet playing with<br>feet, but is rolling over. L<br>leg still most active - also<br>still rolling toward R. Mother<br>reports this is typical.                                       |
| 7-14 | F     | Straight                   | L           |                                                                                                                                                                                             |
| 7-19 | -     | -                          | L           |                                                                                                                                                                                             |
| 7-21 | L     | Straight                   | L           |                                                                                                                                                                                             |
| 8-3  | -     | -                          | L           |                                                                                                                                                                                             |

SUBJECT 8  
(Baby boy Dan)

|      |   |                             |      |  |
|------|---|-----------------------------|------|--|
| 2-21 | R | Straight on<br>Mother's lap | R    |  |
| 2-22 | F | Straight                    | L    |  |
| 2-23 | G | Straight on<br>Mother's lap | Same |  |
| 2-28 | F | On R side -<br>R res.       | R    |  |
| 3-1  | F | Head s. L                   |      |  |
| 3-2  | - | S. on R side -<br>R res.    | R    |  |
| 3-3  | F | S. on L side -<br>L res.    | L    |  |
| 3-20 | F | Straight                    | R    |  |
| 3-21 | F | S. on R side -<br>R s. res. | Same |  |



| Date | Light | Position                    | Most Active | Remarks                                                                                                                                       |
|------|-------|-----------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 3-24 | F     | S. on L side - L res.       | R           |                                                                                                                                               |
| 3-28 | R     | Straight, on Mother's lap   | R           | Sucking R fingers.                                                                                                                            |
| 3-31 | F     | S. on L side - L s. res.    | L           | Movement almost altogether finger and hand movement.                                                                                          |
| 4-4  | G     | On L side - L quite res.    | L           |                                                                                                                                               |
| 4-7  | F     | Straight                    | R           |                                                                                                                                               |
| 4-11 | F     | Straight                    | Same        |                                                                                                                                               |
| 4-14 | F     | S. on L side - L s. res.    | R           |                                                                                                                                               |
| 4-21 | G     | Straight                    | R           | Baby watching hands and playing with them. Sucking either hand today.                                                                         |
| 4-25 | F     | Straight                    | R           | R seems to have larger movements.                                                                                                             |
| 4-28 | F     | Head R                      | R           |                                                                                                                                               |
| 5-2  | F     | S. on L side, L s. res.     | R           | L really more active than R - much L finger movement when none of R.                                                                          |
| 5-9  | -     | On L side, L res.           | R           |                                                                                                                                               |
| 5-12 | F     | Straight                    | Same        | Seems to be watching R hand more than L. Is grasping rung of bed with R and manipulating it - is placed nearer R than L side of bed, however. |
| 5-16 | F     | Turned s. L, arms free      | Same        |                                                                                                                                               |
| 5-30 | -     | Turned L, L arm s. res.     | Same        | Seems to be looking at both hands in center front.                                                                                            |
| 6-2  | F     | Straight, but R arm s. res. | R           |                                                                                                                                               |
| 6-9  | F     | Turned R - R s. res.        | R           |                                                                                                                                               |
| 6-13 | G     | Straight                    | R           |                                                                                                                                               |
| 6-16 | G     | Turned s. L - L s. res.     | R           |                                                                                                                                               |
| 6-19 | L     | Straight                    | R           | Baby does not reach for feet.                                                                                                                 |

| Date | Light | Position                     | Most Active | Remarks                                                                                                                                                                                                                                                                                                   |
|------|-------|------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6-22 | -     | Turned on L side - L s. res. | L           | Sucking L fingers - clutching dress with R hand.                                                                                                                                                                                                                                                          |
| 6-29 | R     | Lying on floor               | Same        | Baby has not made effort to reach for feet. Legs extend rigidly instead of being flexed at knees. Gets quite tense in the knees. Is trying to roll, but pushes himself over instead of swinging himself over as the other babies do. Rolls toward both sides, but apparently more toward L than toward R. |

|      |  |  |      |  |
|------|--|--|------|--|
| 7-25 |  |  | L    |  |
| 7-26 |  |  | Same |  |
| 7-27 |  |  | L    |  |
| 7-28 |  |  | R    |  |
| 7-29 |  |  | L    |  |

SUBJECT 9  
(Baby boy Oscar)

|      |   |                            |      |                                                                          |
|------|---|----------------------------|------|--------------------------------------------------------------------------|
| 1-24 | H | Head L                     | L    |                                                                          |
| 1-25 | H | Head R                     | R    | Baby ill during the night.                                               |
| 1-26 | H | Head L                     | R    |                                                                          |
| 1-27 | H | Head R                     | L    |                                                                          |
| 1-30 | H | Head L                     | Same |                                                                          |
| 1-31 | H | Head L                     | Same |                                                                          |
| 2-1  | H | Head L                     | R    |                                                                          |
| 2-2  | H | Turned s. L,<br>L s. res.  | R    |                                                                          |
| 2-22 | H | Head alternated<br>R and L | Same |                                                                          |
| 2-24 | H | Head alternated<br>R and L | R    |                                                                          |
| 2-27 | H | Head L                     | R    |                                                                          |
| 2-28 | H | Straight                   | R    |                                                                          |
| 3-1  | H | Head L                     | R    | Holding on rung of crib with L. Equally close to both sides - small bed. |
| 3-2  | H | Head R                     | L    |                                                                          |

| Date | Light | Position                        | Most Active | Remarks                                                                                                          |
|------|-------|---------------------------------|-------------|------------------------------------------------------------------------------------------------------------------|
| 4-24 | H     | Head alternated R and L         | Same        | Larger activity of L, L grasps rungs of bed, and seems to watch L out in front of face more than R.              |
| 4-27 | G     | Straight                        | L           | L seems more skillful than R. Grasps rung of bed and general movements of L seem more "mature."                  |
| 5-4  | L     | Head L                          | L           |                                                                                                                  |
| 5-8  | L     | Straight                        | L           |                                                                                                                  |
| 5-11 | G     | Straight                        | L           |                                                                                                                  |
| 5-15 | R     | Straight                        | L           | Sucking L thumb. Grasping L sides of bed.                                                                        |
| 6-1  | G     | Head alternated R and L         | Same        | L movements seem larger.                                                                                         |
| 6-5  | G     | Straight                        | L           | Took pacifier out of mouth with L and held it in L for some time.                                                |
| 4-10 | F     | S. on R side - R s. res.        | R           |                                                                                                                  |
| 4-13 | F     | Turned on R side, R res.        | L           |                                                                                                                  |
| 4-17 | F     | Head L                          | R           |                                                                                                                  |
| 4-20 | F     | Head L                          | R           |                                                                                                                  |
| 4-24 | H     | Head L                          | R           | R movements larger than L. Movement often starts in R before spreading to L, sometimes starting in L first, too. |
| 4-28 | F     | Head R                          | R           |                                                                                                                  |
| 5-1  | H     | Turned s. on L side - L s. res. | L           |                                                                                                                  |
| 5-4  | -     | On R side - R res.              | Same        |                                                                                                                  |
| 5-8  | R     | Head R                          | Same        | R leg more active than R arm. Larger movements of R leg and arm.                                                 |
| 5-15 | -     | Turned s. on R side - R s. res. | L           |                                                                                                                  |
| 5-25 | R     | Turned s. on R side - R s. res. | L           |                                                                                                                  |

| Date                                    | Light           | Position                               | Most Active | Remarks                                                                                                     |
|-----------------------------------------|-----------------|----------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------|
| 6-5                                     | H               | Turned s. on R side - R s. res.        | R           |                                                                                                             |
| 6-7                                     | H               | Turned on R side - R s. res.           | L           | L arm much more active than R.                                                                              |
| 6-12                                    | R               | Head R                                 | Same        | Tried to roll toward R.                                                                                     |
| 6-19                                    | -               | Turned s. on R side - R s. res.        | L           | L leg as well as L arm more active.                                                                         |
| 6-22                                    | L               | On L side - L res.                     | R           | Larger movements of R, but L was considerably restricted.                                                   |
| 6-29                                    | L first, then R | S. on L side, at first - then on back. | L           | L leg much more active<br>Tending to roll toward R side - swinging of L leg seems responsible for the roll. |
| 7-19                                    | L               | Straight                               | Same        | Seems to hold both hands out in front of face together.                                                     |
| 7-21                                    | L               | Head R                                 | L           |                                                                                                             |
| SUBJECT <u>11</u><br>(Baby boy William) |                 |                                        |             |                                                                                                             |
| 4-18                                    | G               | Head L                                 | R           | Sucked L hand part of time. R arm movements seemed larger, however.                                         |
| 4-21                                    | G               | Head L - L s. res.                     | R           |                                                                                                             |
| 4-25                                    | R               | S. on L side - L s. res.               | R           |                                                                                                             |
| 4-28                                    | L               | S. on R side - R s. res.               | Same        | Seemed to have larger L. movements.                                                                         |
| 5-9                                     | R               | Turned s. L - L s. res.                | L           |                                                                                                             |
| 5-12                                    | R               | Head R                                 | Same        | R hand manipulated side of basket more than L.                                                              |
| 5-16                                    | G               | Turned s. on L side - L s. res.        | L           |                                                                                                             |
| 5-23                                    | G               | S. on R side - R s. res.               | L           |                                                                                                             |
| 5-26                                    | R               | Turned s. R - R s. res.                | R           | Sucking R thumb occasionally.                                                                               |
| 6-2                                     | G               | Straight                               | R           | R movements larger than L.                                                                                  |
| 6-6                                     | G               | Straight                               | L           | R really more active than L - accident of waking up during an L period. Larger movements of R.              |

| Date | Light | Position | Most Active | Remarks                                                                                                                                                                                                                  |
|------|-------|----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6-9  | -     | Straight | Same        |                                                                                                                                                                                                                          |
| 6-13 | H     | Head R   | R           |                                                                                                                                                                                                                          |
| 6-20 | G     | Straight | R           | Sucking R thumb and finger.                                                                                                                                                                                              |
| 6-23 | G     | Head R   | R           |                                                                                                                                                                                                                          |
| 6-28 | L     | Straight | Same        | Sucking R fingers. Tending to roll toward L, legs coming up into air with R more vigorous, thus turning baby toward L. Precocious child, physically - weighs 14½ lbs. now. Very active, though - large, rather than fat. |
| 7-20 | G     | Straight | R           | Mother reports did turn toward L consistently when first started rolling.                                                                                                                                                |
| 7-22 | G     | Straight | R           |                                                                                                                                                                                                                          |

## Notes on New-borns

Subject 12 -- Boy baby Winslow  
(Born 7-2)

| Date                                             | Light | Position | Most Active Timing Record | Remarks                                                                                                |
|--------------------------------------------------|-------|----------|---------------------------|--------------------------------------------------------------------------------------------------------|
| 7-4                                              |       |          |                           |                                                                                                        |
| Part A                                           | L     | Head R   | Same                      | L really most active.                                                                                  |
| Part B                                           | L     | Head L   | L                         | L considerably more active - L fingers encountered mouth and sucking movements took place.             |
| Day's total....No difference.....L.....L         |       |          |                           |                                                                                                        |
| 7-5                                              |       |          |                           |                                                                                                        |
| Part A                                           | L     | Head L   | R                         | L most active part time, R part time --rest of time about same.                                        |
| Part B                                           | L     | Head L   | L                         | L slightly more active - no arm movements, only finger movements. Strenuous sucking movements of jaws. |
| Day's total....L.....L.....About same.           |       |          |                           |                                                                                                        |
| 7-6                                              |       |          |                           |                                                                                                        |
| Part A                                           | R     | Head L   | R                         | L really most active - difference favoring R an accident -- weakness of technique.                     |
| Part B                                           | R     | Head L   | R                         | R slightly more active.                                                                                |
| Day's total....L.....R.....L really most active. |       |          |                           |                                                                                                        |



| Date                                                 | Light | Position                                        | Most Active<br>Timing Record | Remarks                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------|-------|-------------------------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7-7                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | R     | Head L                                          | L                            | L most active.                                                                                                                                                                                                                                                                                                       |
| Day's total....L.....L.....L                         |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-8                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | R     | Head L greater<br>part of time                  | R                            | L most active part of time<br>-- most time no difference.                                                                                                                                                                                                                                                            |
| Part B                                               | R     | Head L                                          | L                            | L most active.                                                                                                                                                                                                                                                                                                       |
| Day's total....L.....L.....L                         |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-9                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | R     | On R side, R<br>arm slightly<br>less free.      | L                            | Not much real difference.<br>L perhaps slightly more active.<br>Eyes seem not so well coordi-<br>nated as those of other babies.                                                                                                                                                                                     |
| Part B                                               | R     | Still somewhat<br>on R side.                    | R                            | R somewhat.                                                                                                                                                                                                                                                                                                          |
| Day's total....--.....L.....About same.              |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-10                                                 |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | R     | Head R                                          | Same                         | No real difference.                                                                                                                                                                                                                                                                                                  |
| Part B                                               | R     | Head R                                          | Same                         | R really most active.                                                                                                                                                                                                                                                                                                |
| Day's total....R.....S.....R                         |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Subject <u>13</u> -- Boy baby Brundage<br>(Born 7-2) |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-4                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | L     | Somewhat on R<br>side -- R arm<br>s. less free. | R                            | R slightly more active. R<br>arm less free, but movement<br>largely finger movement.                                                                                                                                                                                                                                 |
| Part B                                               | L     | On R side                                       | R                            | R most active.                                                                                                                                                                                                                                                                                                       |
| Day's total....--.....R.....R                        |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-5                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | F     | On R side                                       | L                            | L enormously more active<br>during part of time -- some-<br>what more active rest. Unusual<br>amount of activity during first<br>period of left arm and hand,<br>with relatively little of R --<br>whole record weighted in favor<br>of L through this one score,<br>but score represents what real-<br>ly happened. |
| Part B                                               | F     | On R side                                       | R                            | R most active part of time,<br>L part of time.                                                                                                                                                                                                                                                                       |
| Day's total....--.....L.....L                        |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| 7-6                                                  |       |                                                 |                              |                                                                                                                                                                                                                                                                                                                      |
| Part A                                               | F     | On L side                                       | R                            | No great difference -- R<br>slightly more active one peri-<br>od, L one, no difference one.<br>L arm more restricted, but hand<br>free.                                                                                                                                                                              |

| Date                             | Light | Position  | Most Active<br>Timing Record | Remarks                                                                      |
|----------------------------------|-------|-----------|------------------------------|------------------------------------------------------------------------------|
| Part B                           | F     | On L side | R                            | No great difference -- R one Period, L one period, no difference one period. |
| Day's total....--.....R.....Same |       |           |                              |                                                                              |

7-7

|                              |   |        |   |                    |
|------------------------------|---|--------|---|--------------------|
| Part A                       | F | Head L | R | Right most active. |
| Day's total....L.....R.....R |   |        |   |                    |

7-8

|        |   |        |   |                              |
|--------|---|--------|---|------------------------------|
| Part A | F | Head R | R | Very little real difference. |
|--------|---|--------|---|------------------------------|

|        |   |                                                 |   |             |
|--------|---|-------------------------------------------------|---|-------------|
| Part B | F | Head R part time,<br>on R side rest of<br>time. | R | R somewhat. |
|--------|---|-------------------------------------------------|---|-------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....R.....R.....R |  |  |  |  |
|------------------------------|--|--|--|--|

7-9

|        |   |                                                        |   |                |
|--------|---|--------------------------------------------------------|---|----------------|
| Part A | F | Head R first<br>period, on L side<br>last two periods. | R | R most active. |
|--------|---|--------------------------------------------------------|---|----------------|

|        |   |           |   |             |
|--------|---|-----------|---|-------------|
| Part B | F | On L side | L | L slightly. |
|--------|---|-----------|---|-------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....R.....R.....R |  |  |  |  |
|------------------------------|--|--|--|--|

7-10

|        |   |        |   |             |
|--------|---|--------|---|-------------|
| Part A | F | Head L | L | L slightly. |
|--------|---|--------|---|-------------|

|        |   |        |   |             |
|--------|---|--------|---|-------------|
| Part B | F | Head L | R | R slightly. |
|--------|---|--------|---|-------------|

|                                    |  |  |  |  |
|------------------------------------|--|--|--|--|
| Day's total....L.....Same.....Same |  |  |  |  |
|------------------------------------|--|--|--|--|

Subject 14 -- Girl baby Bergen  
(Born 7-3)

7-4

|        |   |        |   |                                               |
|--------|---|--------|---|-----------------------------------------------|
| Part A | L | Head L | R | L really most active - weakness in technique. |
|--------|---|--------|---|-----------------------------------------------|

|        |   |        |   |                               |
|--------|---|--------|---|-------------------------------|
| Part B | L | Head L | R | L again slightly more active. |
|--------|---|--------|---|-------------------------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....L.....R.....L |  |  |  |  |
|------------------------------|--|--|--|--|

7-5

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part A | R | Head R | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |                             |   |                         |
|--------|---|-----------------------------|---|-------------------------|
| Part B | R | Head R at<br>first, later L | L | L slightly more active. |
|--------|---|-----------------------------|---|-------------------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....R.....L.....R |  |  |  |  |
|------------------------------|--|--|--|--|

7-6

|        |   |        |   |                             |
|--------|---|--------|---|-----------------------------|
| Part A | R | Head R | R | R considerably more active. |
|--------|---|--------|---|-----------------------------|

|        |   |        |   |                         |
|--------|---|--------|---|-------------------------|
| Part B | R | Head R | R | R slightly more active. |
|--------|---|--------|---|-------------------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....R.....R.....R |  |  |  |  |
|------------------------------|--|--|--|--|

7-7

|        |   |        |      |                     |
|--------|---|--------|------|---------------------|
| Part A | R | Head R | Same | No real difference. |
|--------|---|--------|------|---------------------|

|                              |  |  |  |  |
|------------------------------|--|--|--|--|
| Day's total....R.....S.....S |  |  |  |  |
|------------------------------|--|--|--|--|

7-8

|        |   |                                 |   |                     |
|--------|---|---------------------------------|---|---------------------|
| Part A | R | Head L, then R,<br>then L again | L | No real difference. |
|--------|---|---------------------------------|---|---------------------|

| Date                                                | Light | Position                                                   | Most Active   | Remarks                                                                                                                                                                                               |
|-----------------------------------------------------|-------|------------------------------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                     |       |                                                            | Timing Record |                                                                                                                                                                                                       |
| Part B                                              | R     | Head L                                                     | R             | R most active                                                                                                                                                                                         |
| Day's total...                                      |       | L.....                                                     | R.....        | R                                                                                                                                                                                                     |
| 7-9                                                 |       |                                                            |               |                                                                                                                                                                                                       |
| Part A                                              | R     | Head R, later L                                            | Same          | Alternate R and L.                                                                                                                                                                                    |
| Part B                                              | R     | Head R                                                     | Same          | R slightly.                                                                                                                                                                                           |
| Day's total...                                      |       | R.....                                                     | S.....        | R                                                                                                                                                                                                     |
| 7-10                                                |       |                                                            |               |                                                                                                                                                                                                       |
| Part A                                              | R     | Head R first two periods, L last period.                   | L             | L somewhat more active -- also L foot.                                                                                                                                                                |
| Part B                                              | R     | Head R                                                     | Same          | No real difference.                                                                                                                                                                                   |
| Day's total...                                      |       | R.....                                                     | L.....        | L                                                                                                                                                                                                     |
| 7-11                                                |       |                                                            |               |                                                                                                                                                                                                       |
| Part A                                              | R     | Head R -- last period, on R side.                          | L             | R really slightly more active.                                                                                                                                                                        |
| Part B                                              | R     | On R side, first two periods. On back last period, head R. | R             | R most active.                                                                                                                                                                                        |
| Part C                                              | R     | Head R                                                     | R             | R most active.                                                                                                                                                                                        |
| Part D                                              | R     | Head R                                                     | R             | R most active.                                                                                                                                                                                        |
| Day's total...                                      |       | R.....                                                     | R.....        | R                                                                                                                                                                                                     |
| 7-12                                                |       |                                                            |               |                                                                                                                                                                                                       |
| Part A                                              | R     | On R side                                                  | R             | R most active, although R arm less free.                                                                                                                                                              |
| Part B                                              | R     | On R side                                                  | Same          | R most active -- R arm again less free.                                                                                                                                                               |
| Part C                                              | R     | On R side                                                  | R             | R somewhat more active.                                                                                                                                                                               |
| Day's total....                                     | --    | .....                                                      | R.....        | R                                                                                                                                                                                                     |
| Subject <u>15</u> -- Boy baby Ruelle<br>(Born 7-12) |       |                                                            |               |                                                                                                                                                                                                       |
| 7-13                                                |       |                                                            |               |                                                                                                                                                                                                       |
| Part A                                              | L     | Head R                                                     | R             | Independent movement of two hands, but no real difference in amount.                                                                                                                                  |
| Part B                                              | L     | Head R                                                     | L             | L part time, R part time -- R foot definitely most active.                                                                                                                                            |
| Part C                                              | L     | Head R                                                     | Same          | R really most active - considerable sucking movement. Sometimes have sucking movements preliminary to hand or foot movement -- sometimes the sucking movements follow the hand movements -- sometimes |

| Date | Light | Position | Most Active   | Remarks |
|------|-------|----------|---------------|---------|
|      |       |          | Timing Record |         |

sucking movements alone. This time there was much independent hand and finger movement. Often activity seems to start in small-muscle groups, as fingers toes, or mouth region and then gradually spread to large-muscle groups.

|             |   |        |      |                             |
|-------------|---|--------|------|-----------------------------|
| Part D      | L | Head R | R    | R part time -- L part time. |
| Day's total | R |        | Same | R                           |

7-14

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part A | L | Head R | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part B | L | Head R | R | R most active. |
|--------|---|--------|---|----------------|

|             |   |  |   |   |
|-------------|---|--|---|---|
| Day's total | R |  | R | R |
|-------------|---|--|---|---|

7-15

|        |   |        |   |                                               |
|--------|---|--------|---|-----------------------------------------------|
| Part A | R | Head R | L | R really most active - weakness of technique. |
|--------|---|--------|---|-----------------------------------------------|

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part B | R | Head R | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |                                           |   |                |
|--------|---|-------------------------------------------|---|----------------|
| Part C | R | Head turned back and forth several times. | R | R most active. |
|--------|---|-------------------------------------------|---|----------------|

|             |   |  |   |   |
|-------------|---|--|---|---|
| Day's total | R |  | R | R |
|-------------|---|--|---|---|

7-16

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part A | F | Head L | L | L most active. |
|--------|---|--------|---|----------------|

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part B | F | Head L | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |                       |   |                                         |
|--------|---|-----------------------|---|-----------------------------------------|
| Part C | F | Head L first, then R. | R | R most active, also R foot most active. |
|--------|---|-----------------------|---|-----------------------------------------|

|             |   |  |   |   |
|-------------|---|--|---|---|
| Day's total | L |  | R | R |
|-------------|---|--|---|---|

7-17

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part A | R | Head R | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |        |   |                                                                                 |
|--------|---|--------|---|---------------------------------------------------------------------------------|
| Part B | R | Head R | R | R most active part time, L part time. L foot also more active while L hand was. |
|--------|---|--------|---|---------------------------------------------------------------------------------|

|        |   |        |      |                                       |
|--------|---|--------|------|---------------------------------------|
| Part C | R | Head L | Same | R most active part time, L part time. |
|--------|---|--------|------|---------------------------------------|

|             |   |  |   |   |
|-------------|---|--|---|---|
| Day's total | R |  | R | R |
|-------------|---|--|---|---|

7-18

|        |   |                      |      |                                                       |
|--------|---|----------------------|------|-------------------------------------------------------|
| Part A | F | Head R most of time. | Same | R most active part time, L part time but less than R. |
|--------|---|----------------------|------|-------------------------------------------------------|

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part B | F | Head L | R | R most active. |
|--------|---|--------|---|----------------|

|        |   |        |   |                                |
|--------|---|--------|---|--------------------------------|
| Part C | R | Head L | R | L really slightly more active. |
|--------|---|--------|---|--------------------------------|

|             |   |  |   |   |
|-------------|---|--|---|---|
| Day's total | L |  | R | R |
|-------------|---|--|---|---|

| Date | Light | Position | Most Active<br>Timing Record | Remarks |
|------|-------|----------|------------------------------|---------|
|------|-------|----------|------------------------------|---------|

Subject 16 -- Girl baby Halloran  
(Born 7-19)

7-20

|                              |   |        |   |                                                  |
|------------------------------|---|--------|---|--------------------------------------------------|
| Part A                       | L | Head L | R | R most active.                                   |
| Part B                       | L | Head L | L | L hand most active -- R foot seemed most active. |
| Part C                       | L | Head L | L | L most active.                                   |
| Day's total....L.....L.....L |   |        |   |                                                  |

7-21

|                              |   |                      |      |                                           |
|------------------------------|---|----------------------|------|-------------------------------------------|
| Part A                       | R | Head R most of time. | Same | L most active -- also L foot most active. |
| Part B                       | R | Head R               | L    | L most active.                            |
| Part C                       | R | Head R               | R    | L really most active -- also L foot.      |
| Day's total....R.....L.....L |   |                      |      |                                           |

7-22

|                              |   |        |      |                                                                                                                                                                                                  |
|------------------------------|---|--------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Part A                       | R | Head L | Same | L really most active.                                                                                                                                                                            |
| Part B                       | R | Head L | R    | R most active.                                                                                                                                                                                   |
| Part C                       | R | Head L | L    | L most active -- much independent movement. Deep breathing often precedes movement -- may be foot movement or hand movement -- may be one or both hands or feet, or may be all four extremities. |
| Day's total....L.....L.....L |   |        |      |                                                                                                                                                                                                  |

7-23

|                              |   |        |   |                                                            |
|------------------------------|---|--------|---|------------------------------------------------------------|
| Part A                       | R | Head R | L | L most active -- sucking movements when no other activity. |
| Part B                       | R | Head L | R | L really most active.                                      |
| Part C                       | R | Head L | L | L most active -- also L foot.                              |
| Part D                       | R | Head L | L | L slightly most active.                                    |
| Day's total....L.....L.....L |   |        |   |                                                            |

7-25

|        |   |                                  |      |                                                  |
|--------|---|----------------------------------|------|--------------------------------------------------|
| Part A | R | Head R                           | L    | L hand most active -- R foot seemed most active. |
| Part B | R | Head R part time, L part time    | L    | L hand and R foot still most active.             |
| Part C | R | Head L first two periods, then R | Same | L really most active -- also L foot this time.   |



| Date                          | Light | Position                               | Most Active<br>Timing Record | Remarks        |
|-------------------------------|-------|----------------------------------------|------------------------------|----------------|
| Part D                        | R     | Head R first<br>two periods,<br>then L | R                            | R most active. |
| Day's total....--.....L.....L |       |                                        |                              |                |

Subject 17 -- Boy baby Solomon  
(Born 7-11)

Note.- Right hand abnormal -- has only three digits (thumb and two fingers). Wrist and arm of right side slimmer than those of other side, so that there seems room for only the two fingers. Otherwise baby normal.

7-14

|                                 |   |        |   |                                           |
|---------------------------------|---|--------|---|-------------------------------------------|
| Part A                          | L | Head R | L | L somewhat more active --<br>also L foot. |
| Part B                          | L | Head R | R | R most active.                            |
| Part C                          | L | Head R | L | R really slightly more ac-<br>tive.       |
| Day's total....R.....Same.....R |   |        |   |                                           |

7-15

|                              |   |                         |   |                                  |
|------------------------------|---|-------------------------|---|----------------------------------|
| Part A                       | F | Head L                  | L | L part time -- R part time.      |
| Part B                       | F | Head L                  | R | R most active -- also R<br>foot. |
| Part C                       | F | Head L most<br>of time. | R | R most active -- also R<br>foot. |
| Day's total....L.....R.....R |   |                         |   |                                  |

7-16

|                              |   |        |   |                                                                                                                               |
|------------------------------|---|--------|---|-------------------------------------------------------------------------------------------------------------------------------|
| Part A                       | F | Head R | L | R really most active.                                                                                                         |
| Part B                       | F | Head R | L | R really most active, much<br>R movement when no L movement,<br>while almost all L movement<br>was accompanied by R movement. |
| Part C                       | F | Head R | R | R most active.                                                                                                                |
| Day's total....R.....L.....R |   |        |   |                                                                                                                               |

7-17

|                              |   |                         |   |                       |
|------------------------------|---|-------------------------|---|-----------------------|
| Part A                       | F | Head R                  | R | R most active.        |
| Part B                       | F | Head R                  | R | R most active.        |
| Part C                       | F | Head R most<br>of time. | L | R really most active. |
| Day's total....R.....R.....R |   |                         |   |                       |

7-18

|        |   |        |   |                |
|--------|---|--------|---|----------------|
| Part A | F | Head R | R | R most active. |
| Part B | F | Head R | R | R most active. |

| Date                         | Light | Position | Most Active<br>Timing Record | Remarks                        |
|------------------------------|-------|----------|------------------------------|--------------------------------|
| Part C                       | F     | Head L   | R                            | L really somewhat more active. |
| Day's total....R.....R.....R |       |          |                              |                                |
| 7-19                         |       |          |                              |                                |
| Part A                       | F     | Head L   | L                            | L most active.                 |
| Part B                       | F     | Head L   | R                            | L really most active.          |
| Part C                       | F     | Head L   | L                            | L most active.                 |
| Day's total....L.....L.....L |       |          |                              |                                |



